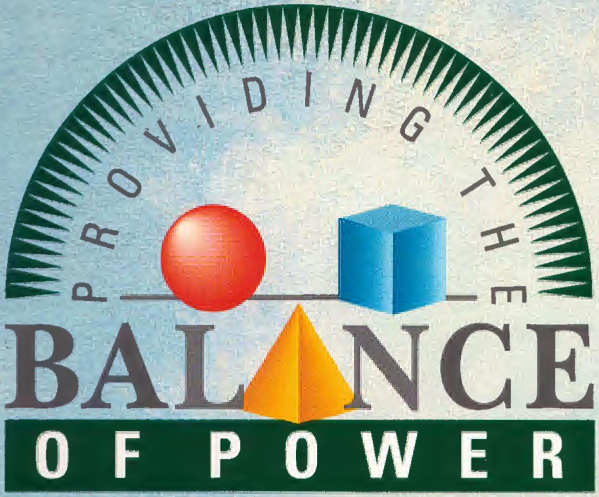

PROVIDING THE BALANCE OF POWER

ONTARIO HYDRO'S PLAN

TO SERVE CUSTOMERS'

ELECTRICITY NEEDS

OVERVIEW

ONTARIO HYDRO

has prepared this overview as part of a family of documents with the common purpose of describing a proposed plan to serve your future electricity needs.

WE WANT YOUR FEEDBACK ...

Hydro is committed to informing the public of its plans and activities – and helping people learn more about the hows and whys and major trade-offs in providing electricity. And we're also committed to making it easy for you to give us your feedback.

THE DEMAND/SUPPLY PLAN

The Plan contains Hydro's requests to the Environmental Assessment Board for approvals necessary to implement the Plan and presents the technical analysis of Hydro's proposals.

THE ENVIRONMENTAL ANALYSIS

This study looks at important social and environmental issues associated with providing electricity. It will tell you what these issues are ... what Ontario Hydro is doing about them ... what this means for meeting the challenges of the future. It also explains Ontario's environmental regulations, environmental assessment process and hearings.

1-800-263-9000

If you would like copies of these documents, more information on how to save money on electricity – or information about any of the issues raised in this book – please call.

HYDRO IS LISTENING ...

Hydro will hold information centres across the province designed to hear your feedback – and we encourage you to attend. Call for information or watch for ads in your local newspaper. If you have a group of people interested in how electricity is produced or in learning about more efficient uses – we'll provide a speaker geared to your interests. This will also be a chance to get your views.

THANK YOU.

PROVIDING THE BALANCE OF POWER

ONTARIO HYDRO'S PLAN

TO SERVE CUSTOMERS'

ELECTRICITY NEEDS

OVERVIEW

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BALANCE

is the goal of Hydro's planning ... balancing future needs for electricity with the resources to meet them. Balancing the things that customers want from electricity such as reliable service, a clean environment, low cost.

Balancing a variety of programs and technologies that will meet these needs – hydraulic development, efficiency improvements, electricity from private producers, purchases from other utilities and Hydro-owned generating stations.

Achieving Balance involves three activities – assessing needs, defining resources and making plans. These activities are represented by three geometric symbols – the sphere, the cube, the pyramid.

ASSESSING NEEDS

Electricity will be expected to provide a range of services over the next 25 years in home, work, recreation and community activities. Hydro's planning assesses these needs and compares them to the resources available to meet them.

DEFINING RESOURCES

Resources here means not just natural resources, but the existing facilities and future options available to meet customer needs. Planning requires techniques to evaluate options to reduce the demand for electricity or to increase supply.

MAKING PLANS

This represents the balance point between needs and resources. As needs grow and existing resources decline, plans must add the right amount of new resources to maintain the balance.

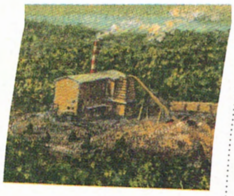
A SUMMARY

The Need For Electricity

Wherever you're reading this, chances are electricity is close at hand. And if you're not using electricity in some form at this very moment, you certainly will be before many more moments go by. • Electricity is one of the most common, most vital and yet most taken-for-granted commodities that make up our way of life. And as our way of life evolves, our demand for the kinds of things we want electricity to provide is also growing – more and better products to make our work easier and more productive, and our leisure time more enjoyable. • Nobody's crystal ball is crystal clear. There are many uncertainties about forecasting. But Ontario Hydro's best estimate is that by the year 2014 – only a quarter of a century away – we Ontarians will be needing some 50 to 100 per cent more electrical power than we use today. • And we will still want it to be supplied with as few interruptions as possible, as reasonably priced as possible and with as little damage to the environment as possible. Ontario Hydro's job is to fulfill these desires.

Making Sure We Have Enough

At the same time that Ontario's electricity needs are growing over the next 25 years, Ontario Hydro's ability to meet those needs will be diminishing. Generating stations, while comparatively long-lived (some of our water-powered generating stations date back to the turn of the century) do age, and eventually wear out. By the year 2014, between 20 per cent and 30 per cent of Hydro's major supply stations will have to be retired. • Two critical factors, *then, dictate the need for action now: the growing needs and expectations of the people of Ontario; and the fact that some Ontario Hydro generating stations are getting old and will have to be replaced. It's clear that Hydro's ability to meet future electricity needs requires some action.*



The Environment

Ontario Hydro is a publicly-owned company whose shareholders are the people of Ontario. When they talk about their electricity needs, they're talking about more than a reliable supply and a reasonable price. • Just as important to them is the need to balance economic and technical considerations with social and environmental considerations. This means that plans for the future must be made with a lot of thought. It also means that the wishes and concerns of the people of Ontario must be vigorously represented in the planning process.

A Balanced Approach

Rather than simply building new generating stations, Hydro wants to diversify its approach. A balanced plan essentially tries to reduce growth in demand as well as increase supply. In both areas, there are opportunities to tap large numbers of small sources – individual homeowners and business people; small private power producers; and small to medium-sized hydraulic sites.

Working With Customers to Save

The first key element of the proposed plan is to work with customers – residential, commercial and industrial – to help use electricity more efficiently in order to slow the rate of increase in demand. This doesn't mean a lower standard of living for Ontario. It means we'll be doing the same jobs and enjoying the same home life with less electrical power. • This will be accomplished through the use of such measures as more efficient light bulbs, weather-stripping and other simple energy-savers in homes; high-efficiency motors in industry; and using electricity in off-peak periods. These and many other steps will help us save money and reduce waste, help us get the most out of the existing electricity generating system, reduce the need to build new stations – and help protect the environment. • Together, these "better-use" measures can look after about 25 per cent of the future requirements resulting from increased customer needs and retiring stations.

Buying Power from Others

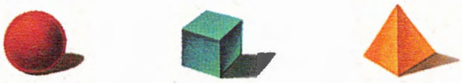
Still, we'll need increased supply as well as better efficiency. For some of this new supply we can look to others. These might be private industries, individuals or municipal utilities, who can generate electricity to meet their own needs and sell their surplus to Ontario Hydro. • Some new supply can also come from neighbouring utilities. Hydro has already planned to purchase power, under a long-term contract, from Manitoba Hydro. • We can expect to get about 12 per cent of future requirements from these sources.

Making the Most of Water Power

Hydro-electric or hydraulic power is a highly desirable form of electricity production. It's renewable and it doesn't produce any waste. Ontario Hydro plans to use as much of it as possible, again with care for the environment. • People are often surprised to hear that Ontario doesn't have a super-abundance of water-power potential. The fact is, to get power from water, that water has to fall, and Ontario is a comparatively "flat" province. The other fact is that most of its major water-power sites have been developed. • Nevertheless, there are a lot of economic small and medium-sized sites that can be developed, particularly in Northern Ontario, and some existing ones that can be redeveloped. • Taking full advantage of Ontario's water power will contribute to about 10 per cent of future requirements. • Together, added water power, purchases from others, independent generation and more efficiency will make up about half of Ontario's new electricity requirements over the coming quarter century.

Making up the Balance

Where will the other half come from? Ontario Hydro has looked at a number of options, including generating stations using uranium, coal, gas or oil as fuel. We analyzed costs, technical soundness and environmental effects, and came up with a plan that will use nuclear stations for meeting the increased day-to-day demand, and gas-fired plants for meeting the peaks. • We chose nuclear for the "work-horse" because of low costs and because it causes no air pollution.



We chose natural gas for peak demand periods because gas-fired plants are inexpensive to build, flexible to operate and cause comparatively little pollution. • Nuclear and natural gas generating stations, then, will account for the other half of Ontario's future requirements. By the end of the 25-year planning period, Ontario Hydro's power generation capacity would be made up of 23 per cent water power, 27 per cent coal, oil, and gas, and 50 per cent nuclear. • Hydro will also follow research and developments in other technologies, such as solar and wind generation, so that we can take advantage when breakthroughs are made.

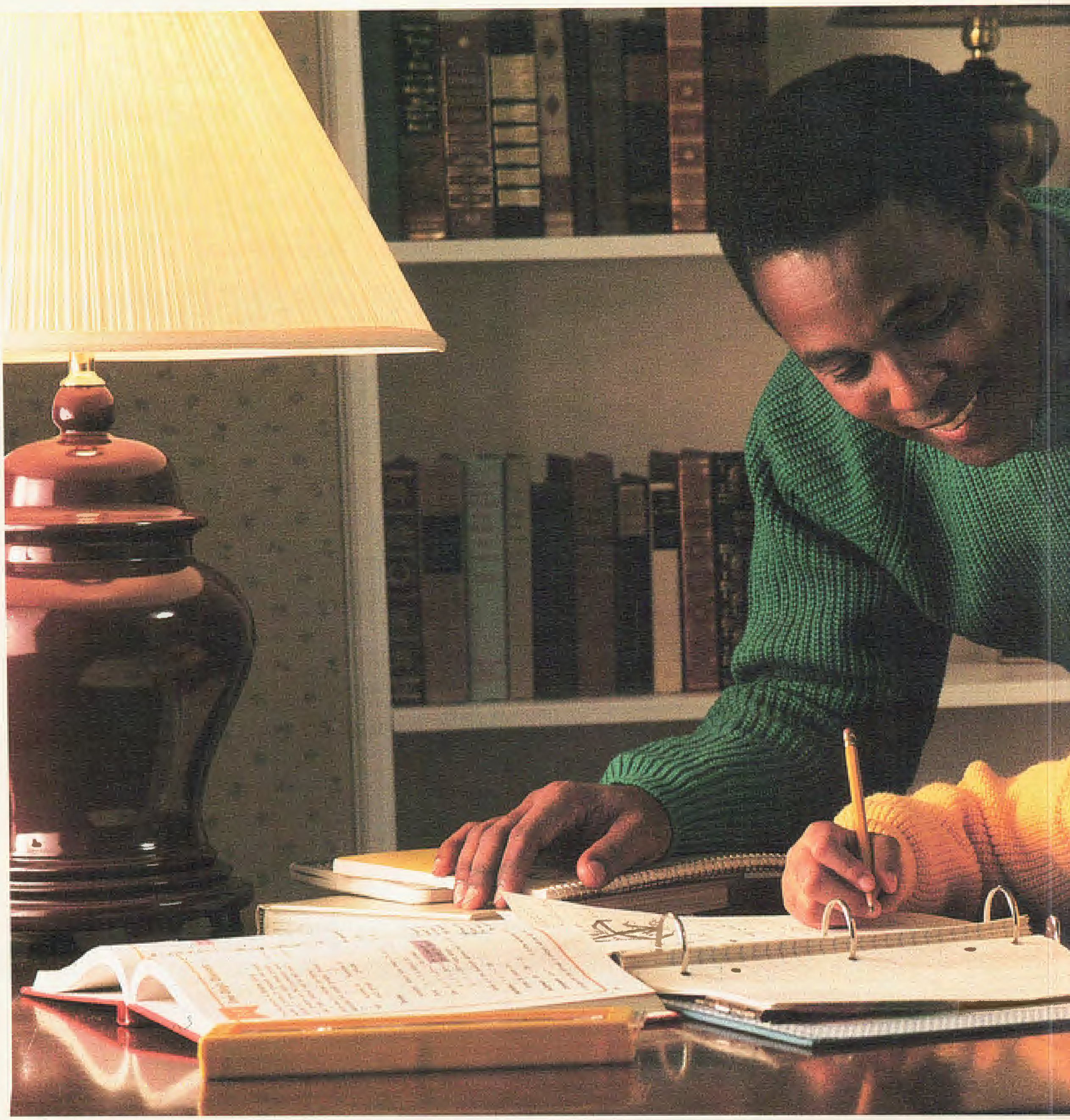
The Need For Decisions

Electricity can't be stored. It must be manufactured and delivered instantaneously on demand. It takes a long time – as long as 14 years in some cases – to plan, get approvals for and build power plants. If we fail to plan far enough ahead, circumstances may force us to make poor choices. • Some of the measures in Hydro's proposed plan can start meeting needs as early as two or three years from now – for example, some of the efficiency programs, some station redevelopment and some independent generation projects. But big stations and major purchases, which are also required, need long lead times. And that means making decisions and getting approvals.

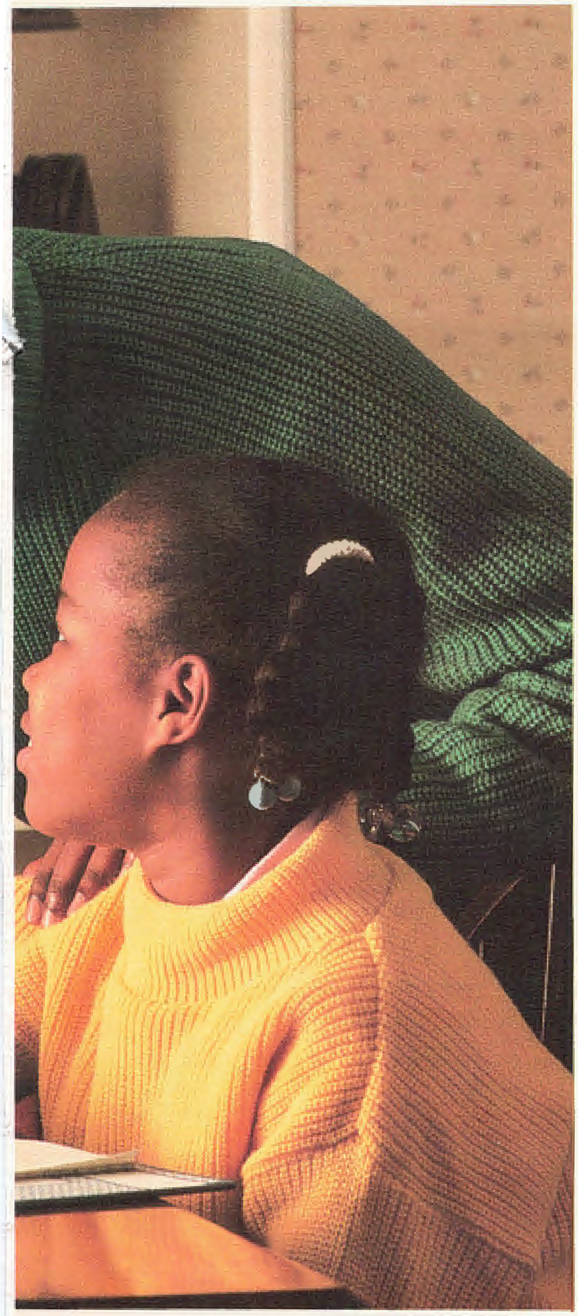
For Public Discussion

Ontario Hydro will seek approval for a five-year action plan that involves a number of hydraulic projects, two nuclear stations and 32 combustion turbine units which run on natural gas, some of which can be developed at existing generating station sites. • Hydro will launch a Public Feedback Program and there will be public hearings on the social and environmental implications of Hydro's proposed plan, as well as on specific sites. No generating station, whether nuclear, hydraulic, gas or coal, will be built on any Ontario site without extensive public discussion. • Hydro's Demand/Supply Plan report is a legal document that will be submitted to the Ontario government and its Environmental Assessment Board as part of the review.

1. WHY ONTARIO NEEDS AN ELECTRICITY PLAN NOW



Ontario Hydro provides the people of Ontario with reliable electricity service at reasonable cost.



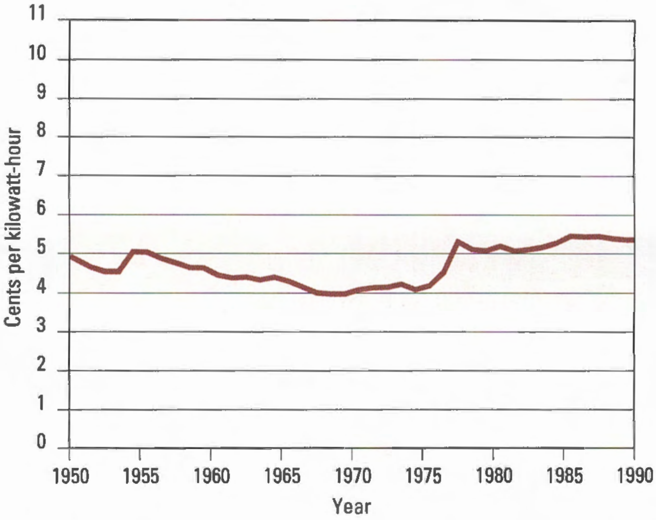
Chapter One

ELECTRICITY ... THE ENERGY WE TAKE FOR GRANTED

ELECTRICITY

is something just about all Ontarians have in common. Young or old, city dweller or farmer, we depend on electricity for the basics – in the home, on the factory floor, in classrooms, stores, offices, shopping malls, arenas, cottages ... We use electricity for so many things, we hardly ever notice it's there – or how much we need it. We take electricity for granted, unable to see it, touch it or smell it.

Figure 1 **Average Electricity Price for Ontario Hydro Customers**
(1989 Dollars)



Ontario Hydro customers have enjoyed stable electricity prices.

When do we notice the power of electricity to shape our lives? It might be coming home to find all those digital clocks blinking out their message that the power had been off. Or groping in the dark for a burnt-out fuse.

If you're a typical user, you probably appreciate your electricity most when you're forced to be without it.

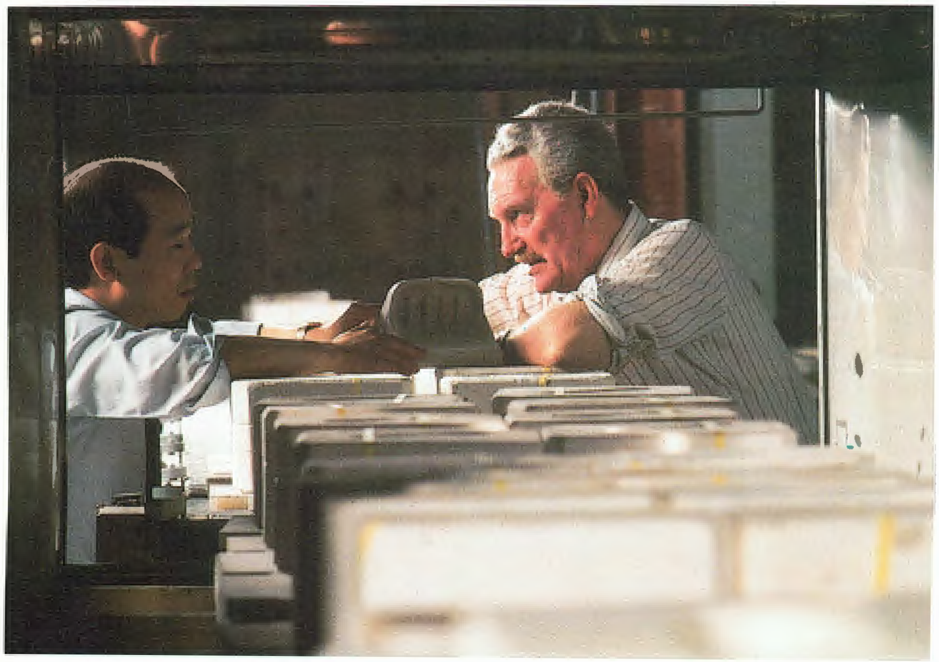
Customers Continue to Expect Reliability & Low Cost

None of us likes to be without power, even for a few minutes. As a resident of Ontario, you've come to expect your lights to go on – every time you flip the switch.

And there's a good reason for that. The fact is this ... For many years, Hydro has provided the people of Ontario with reliable service at reasonable cost (see Figure 1). In other words, not only service that's affordable, but that keeps interruptions to a minimum.

Our customers expect Hydro to maintain this record into the 1990s and beyond. That's why we've prepared a 25-year plan on how to meet Ontario's electricity needs.

Environmental protection means more than controlling emissions.



Customer views are reflected in Hydro's plans.

Evolving Customer Values

Providing electricity to Ontarians is not just a technical exercise – it's also a customer service and a public trust. So what Hydro's customers value is reflected in the system created to serve their needs.

Hydro's customers have always expected reliability and low rates. These are no less important today. But other expectations have taken on heightened importance ...

- *Concern for the environment* – Customers are increasingly concerned about environmental issues. These cover such things as the emissions released by the coal we burn to generate electricity, the storage of radioactive fuel and the use of herbicides along transmission lines.
- *An emphasis on energy efficiency* – Customers recognize they can save money by using more efficient electrical equipment. These and other measures to reduce growth in demand minimize the need for new generating stations and save resources. Hydro has given high priority to these "demand-side" measures.
- *A greater voice for the public in planning* – Customers want their views taken into account when Hydro plans new facilities, especially the siting of generating stations and transmission lines. To meet this need, public reviews and information programs have become a built-in part of Hydro's major planning exercises. For this Plan, Hydro has designed a special information program for public feedback.

The Electricity Planning Challenge

Through most of the 1980s, Ontario has lived through an economic boom. This prosperity has meant new jobs, population growth, more housing, more demand for goods and services. All the forecasts show that economic growth will continue into the next century, though at a somewhat slower pace.

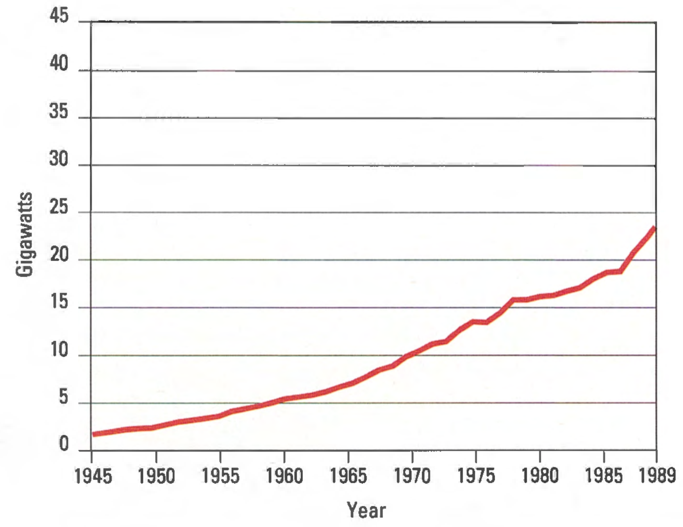
As families grow, as people buy new homes and appliances, and build new businesses, they need more electricity. Figure 2 shows this growth has been going on for some time in Ontario.

Now we face new challenges. As the demand for electricity goes up, our ability to meet that demand from the existing electricity system is declining.

Just like your car or any other piece of equipment, Hydro's generating plants eventually age – even hydraulic plants, which can last 90 years or more. By 2014, the end of Hydro's 25-year planning period, one-quarter of the existing electricity system will have reached the end of its service life.

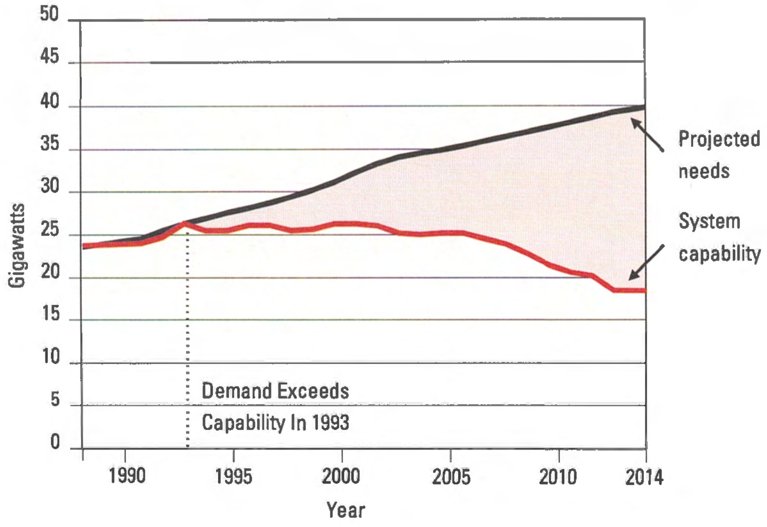
So the challenge is to match the rising demand for electricity with sufficient resources. Figure 3 shows how big the gap between the two would be by 2014 if we relied solely on the existing system.

Figure 2 **Past Demand...**



Electricity demand has grown steadily since 1945 and continues to grow.

Figure 3 **...Rising Needs, Declining Resources**



Without early action, customer needs will begin to exceed Hydro's supply in 1993.

Hydro's Response to Customer Need

An electrical utility faces a number of dilemmas in planning for future customer needs ...

- Many options are available to meet growing customer demand. Some are more expensive than others and may have different social and environmental effects. None of them can do the whole job alone.
- The demand for electricity may grow sharply and unexpectedly. Yet the lead time for getting a major new station designed, approved and built can be as long as 14 years.
- Planning must look out two decades or more to accommodate these long lead times. But the farther out we look, the more uncertain everything becomes – the rate of economic growth, the price of fuels, population size, all the things that affect how much electricity will actually be needed in 20 or 25 years.

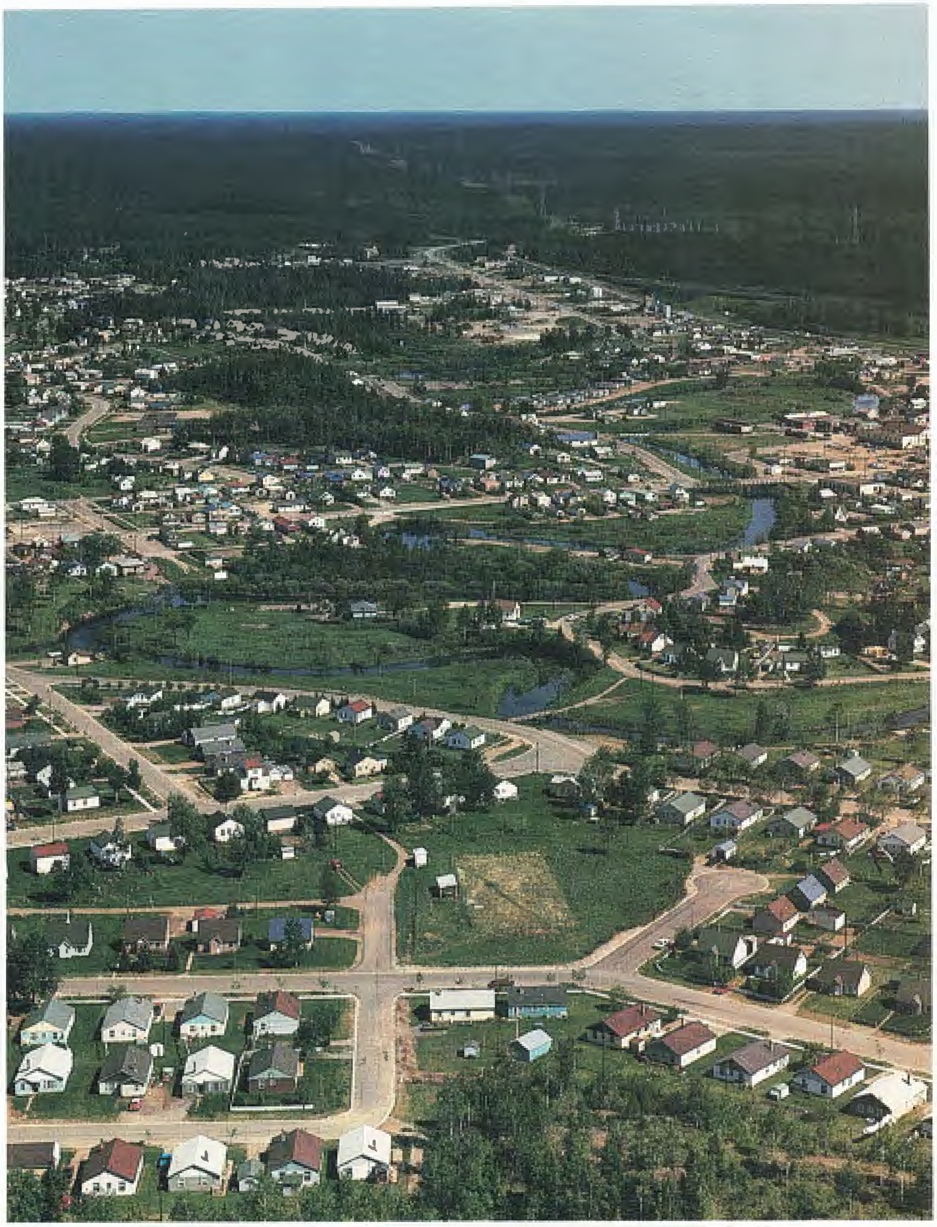
Balancing Needs and Resources

Ontario Hydro's response to these challenges is contained in our proposed Demand/Supply Plan.

The Plan spells out how Hydro proposes to meet Ontario's electricity needs until the year 2014 ... in other words, how Hydro will balance customer needs with electricity resources.

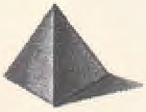
The key features of this 25-year Plan are **flexibility** and **balance** – a mix of options for both reducing the demand for electricity and increasing supply ... Which is why we refer to it as the "Demand/Supply Plan".

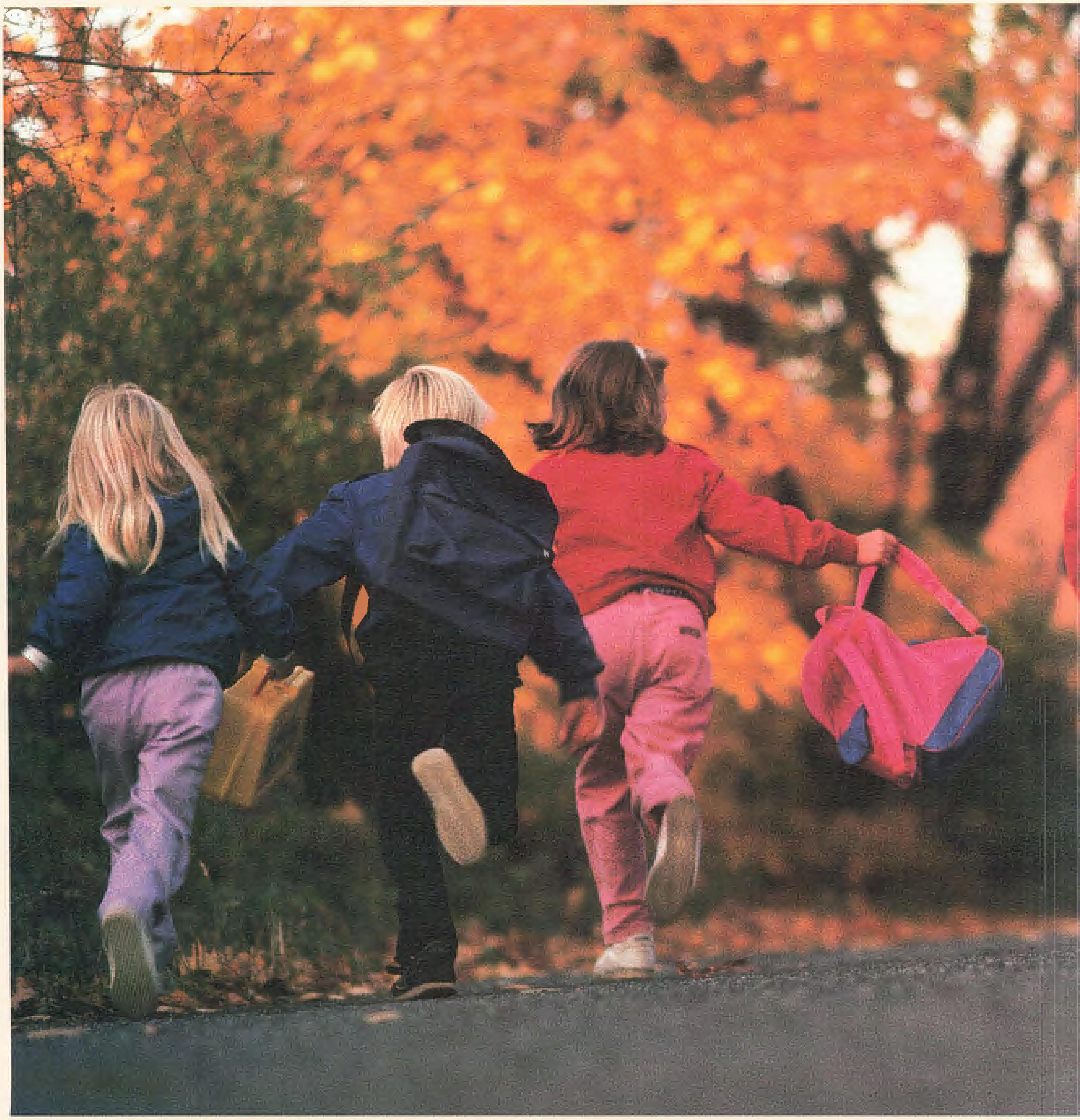
The Plan calls for "demand-side" measures like electrical efficiency improvements, as well as a combination of new major supply sources using natural gas, coal gasification and nuclear reactors. This balanced mix of options will improve the flexibility of our current electricity system and keep customer costs low.



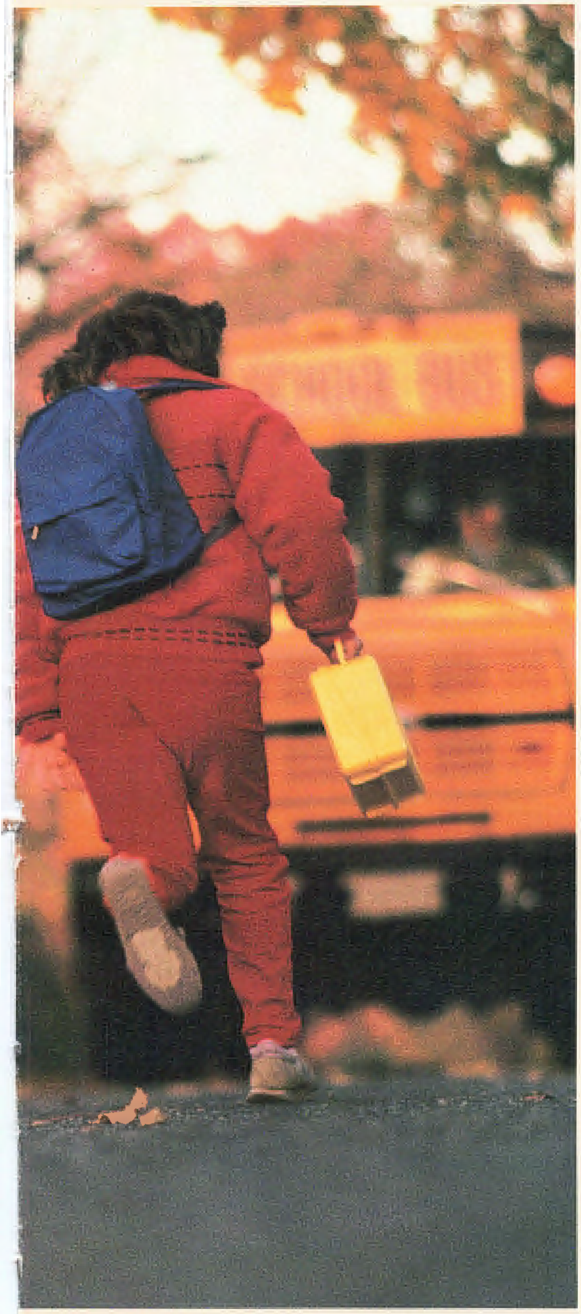
Population growth, the price of fuels and the rate of economic growth affect electricity demand.

2. PEOPLE USING ELECTRICITY





Electricity use peaks as Ontario residents, young and old, get ready to face the day.



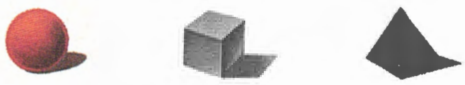
Chapter Two

MEETING ELECTRICITY NEEDS IS A MOMENT-TO-MOMENT BUSINESS

WHEN

you take a shower or cook breakfast in the morning, you have a lot of company. Right across the province, millions of other electricity users like you are also getting ready to face the day at about 6:30 or 7:00. After being fairly quiet all night, Ontario Hydro's supply system suddenly starts getting very busy.

The electricity to cook all those eggs hasn't been stored in your fuse panel or a Hydro transformer, waiting for the morning rush hour. Instead, it's all being generated on demand.



As more customers flip the switch, Hydro's generating stations turn out more electricity. At each and every moment, the amount of electricity flowing through the system is all the electricity that's needed – right now, no sooner, no later.

Electricity can't be stockpiled like other necessities of life. We can't put a supply aside for use tomorrow, like fuel oil or firewood. The facilities to produce it on demand have to be designed and built many years ahead of booms in the economy or extremes in the weather – events that add up to more electricity use.

Growth in Demand Reflects Social & Economic Change

Our need for electricity grows in two different ways.

Most of the traditional uses to which we put electricity – for lighting, heating and so on – keep expanding in step with a growing population and a growing economy.

In addition, our bustling marketplace is constantly finding *new* applications for electricity. Look around a typical office these days. You'll see computers, phone exchanges, fax machines, coffee makers and microwaves, electronic typewriters, photocopiers, air purifiers ... Ten or 15 years ago, a lot of this equipment was still being developed in the lab.

One way utilities measure the impact of these new applications on electricity demand is through "intensity" of use. The amount of new building – such as housing units and office space – keeps growing in Ontario. At the same time, the amount of electricity consumed per square metre has grown.

How We Use Electricity in Ontario

Ontario Hydro provides electricity across the province both directly through its own facilities and indirectly, in association with Ontario's 316 municipal electric utilities.

The municipal utilities distribute power on a retail basis to some 2.4 million customers in local service areas. Hydro also sells power to 105 industrial customers, and operates 50 rural distribution systems to serve over 800,000 customers who are not located within municipal utility service areas.

Altogether, this Hydro family serves about 3.3 million customers in three distinct market sectors:

- Residential/Agricultural – homes, farms, cottages
- Commercial – offices, condominiums, retail stores, hotels, restaurants, institutions, apartments
- Industrial – mining, processing, manufacturing.

Each sector accounts for roughly one-third of total electricity consumption. However, the three sectors differ in their overall size. The residential sector includes 2.7 million customer

Loads and Load Shape

"Load" is the total amount of electrical power needed to meet customer demand at any given time. Total system load is usually measured in thousands of megawatts.

One of the main challenges in utility planning lies in how customers use electricity from hour to hour and day to day. The load or demand on the electricity grid that serves Ontario is constantly fluctuating, in response to millions of personal electricity use decisions – when to cook dinner, how long to run the assembly line or how warm to keep the office.

These fluctuations are significant – from a summer minimum of less than 9,000 megawatts (MW) to a winter maximum of about 23,000, two and a half times as much.

But as Figure 4 shows, these fluctuations are partly predictable – they have a typical "shape". The daily load is high between 7 AM and 11 PM, with peaks typical during the breakfast and dinner periods. Load is lower both at night and on weekends than during the day and on weekdays.

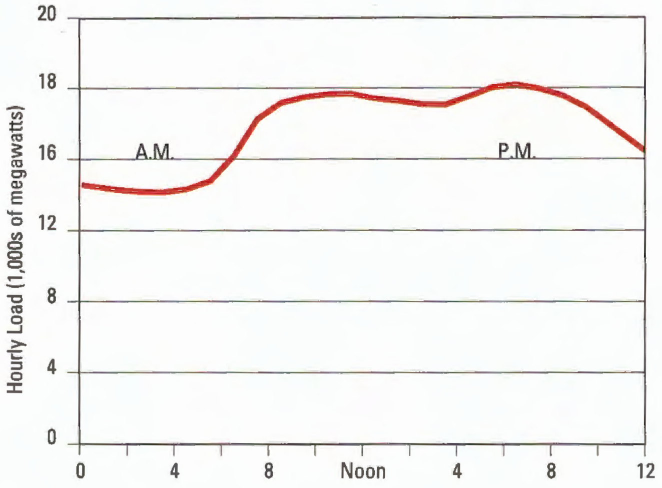
The highest system load for the province as a whole occurs during the coldest period of the winter. In the urban areas of southern Ontario, however, where the reliance on air conditioning is the highest, the annual peak load often occurs during the hottest part of the summer.

Hydro refers to three types of load – base, intermediate and peak. The base load is the steady level of demand that has to be met approximately 70% of the time. Intermediate load has to be met 20 to 70% of the time, while peak load is the maximum demand on the system, which may last up to 20% of the time in a given year.

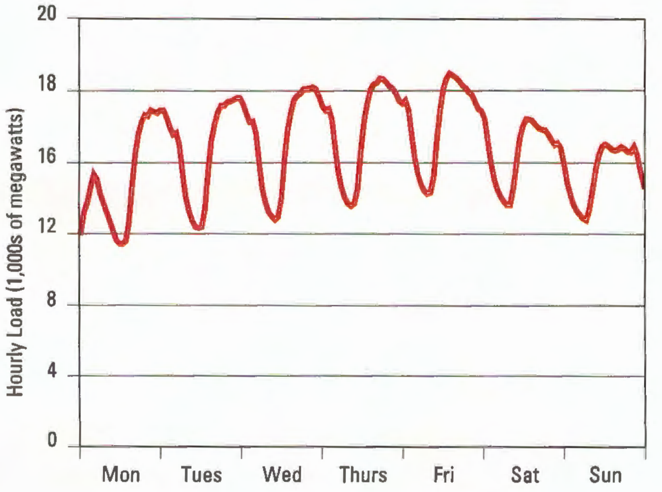
These types of load have a major impact not only on the amount of generating capacity Hydro needs, but also on the kinds of options it employs. For example, nuclear generation is best suited for meeting base load, while certain kinds of fossil generation are more suited for meeting peak loads.

Figure 4 **Daily and Weekly Fluctuations in Electricity Use**

Daily Load Curve Typical Winter Day



Weekly Load Curve Typical Summer Week



Electricity demand fluctuates in response to millions of personal use decisions.

households, the commercial sector 600,000 customer businesses and the industrial sector about 18,000.

The other major difference between sectors lies in the uses customers make of their electricity. Figure 5 shows how we used our electricity in Ontario in 1987. The major end-use in the residential sector was for appliances (nearly half). In the commercial sector it was for lighting (over a third), while in industry it was for motors (almost three-quarters).

Forecasting Demand for Electricity

In every sector, the story's the same – demand for electricity has been growing.

Tracking this past growth is important. But we face a more difficult and critical exercise – trying to predict what will happen to these trends in the future. This is what we call "load forecasting".

Forecasting how much electricity people will use in the future is not unlike the more familiar problem of forecasting the weather. Scientists use large amounts of data about weather patterns, their knowledge of past trends and complex computer models to tell us whether it's likely to rain tomorrow.

The emphasis here is on "likely". When you hear that the "probability of precipitation" is 20%, that means there's a low probability – but no guarantee it won't rain, as everyone knows from personal experience.

If it's so easy to get caught in the rain without an umbrella, imagine the uncertainty in forecasting the energy consumption patterns of millions of people – not just next year or the year after, but 15, 20 and even 25 years into the future.

Ontario Hydro uses mathematical models to process huge amounts of data about Ontario's economy, population trends and energy markets to develop predictions about future electricity use. But no forecast, however sophisticated, can be 100% accurate – and the longer the time horizon, the less reliable the forecast.

Being wrong about future electricity consumption can be costly. If predictions are too low and customers need more electricity than is available, shortages will occur. If predictions are too high and too many stations or purchases have been committed, customers will pay increased rates.

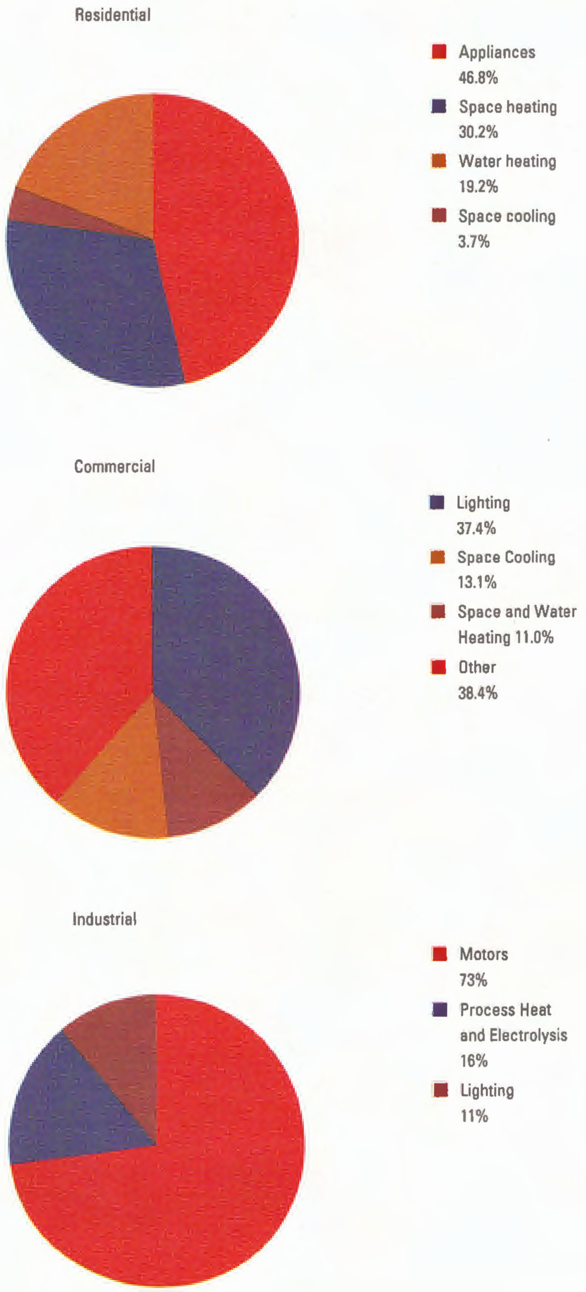
The Uncertainty Factor

Hydro's load forecasts account for this fact of life by using what we call a load growth "bandwidth". Hydro doesn't peg its plans to one firm number – to saying that by such-and-such a year, the customer load or demand will be such-and-such an amount of electricity, no more, no less. There's just too great a chance of being wrong.

Instead, Hydro's strategy is to develop a range of predictions – high, low and in-between. The in-between is known as the "median" forecast.

Hydro designs its forecasts so that the area between the high and low projections covers 80% of what could take place. In other words, we say there's an 80% chance that the actual customer demand in a given year will fall between these two extremes.

Figure 5 **How Electricity Was Used in Ontario (1987)**



Customers in the three major Hydro sectors use electricity in widely different ways.

Manufacturers are major consumers of electricity and suppliers of Ontario jobs.

This bandwidth approach is important for the flexibility of the plans developed by Hydro to serve future electricity needs. All viable system plans must make some allowance for a range of possible load forecasts. This is achieved by planning for some supply capacity that can be installed relatively quickly.

What the Current Forecasts Tell Us

Various forecasting agencies are predicting continued economic growth for the province. These forecasts all show, however, that growth will not continue at the exceptional rate typical of the late 1980s.

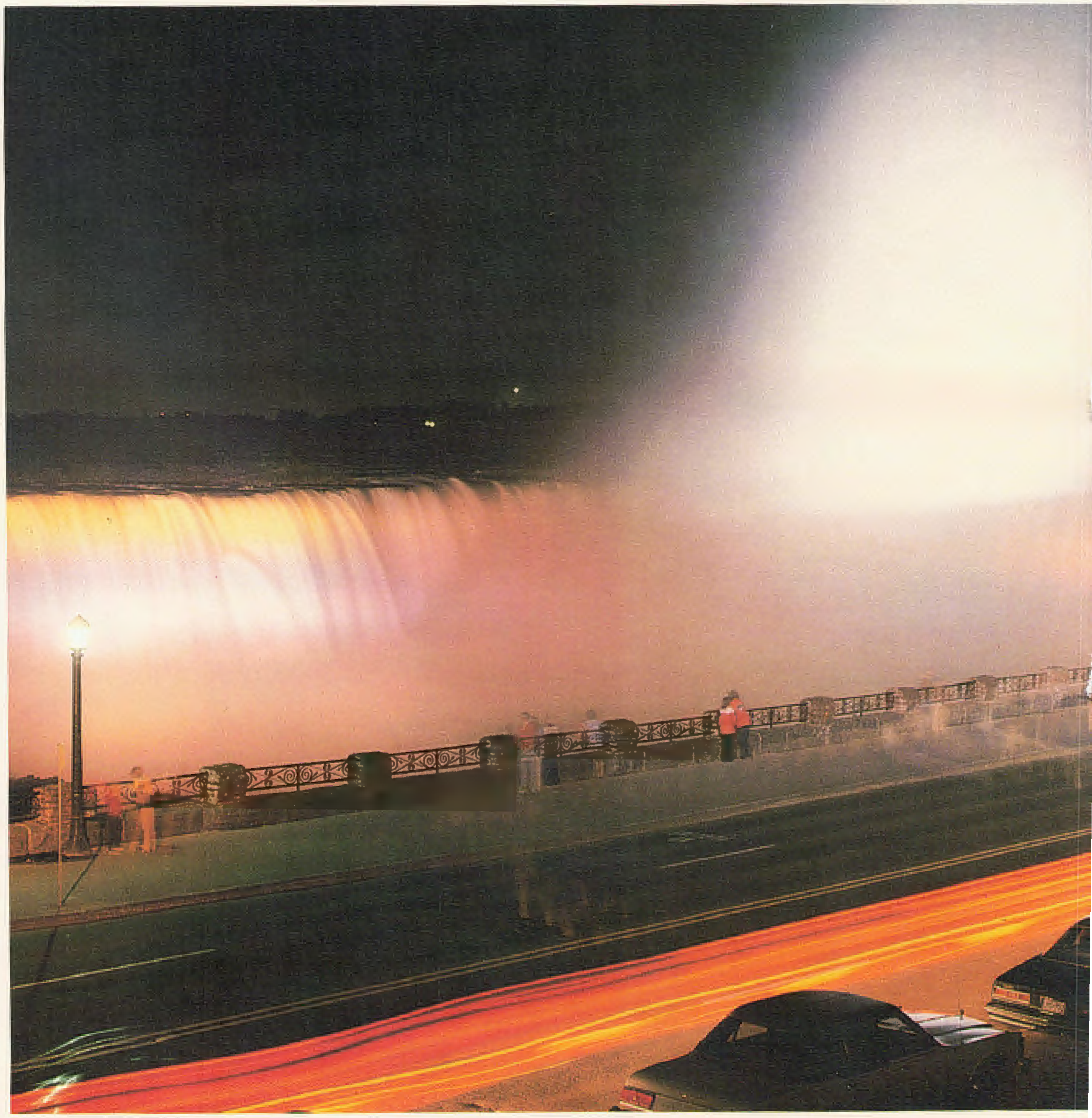
This also applies to electricity demand. For the planning period, we expect the annual load growth to fall between 1.7 and 2.7%, with a median of 2.3%.

The question is therefore not *whether* Ontario will start to run short of electricity if we don't take appropriate action, but *when*. Running short might mean brownouts at certain high-peak times of day ... or during stretches of particularly hot or cold weather.

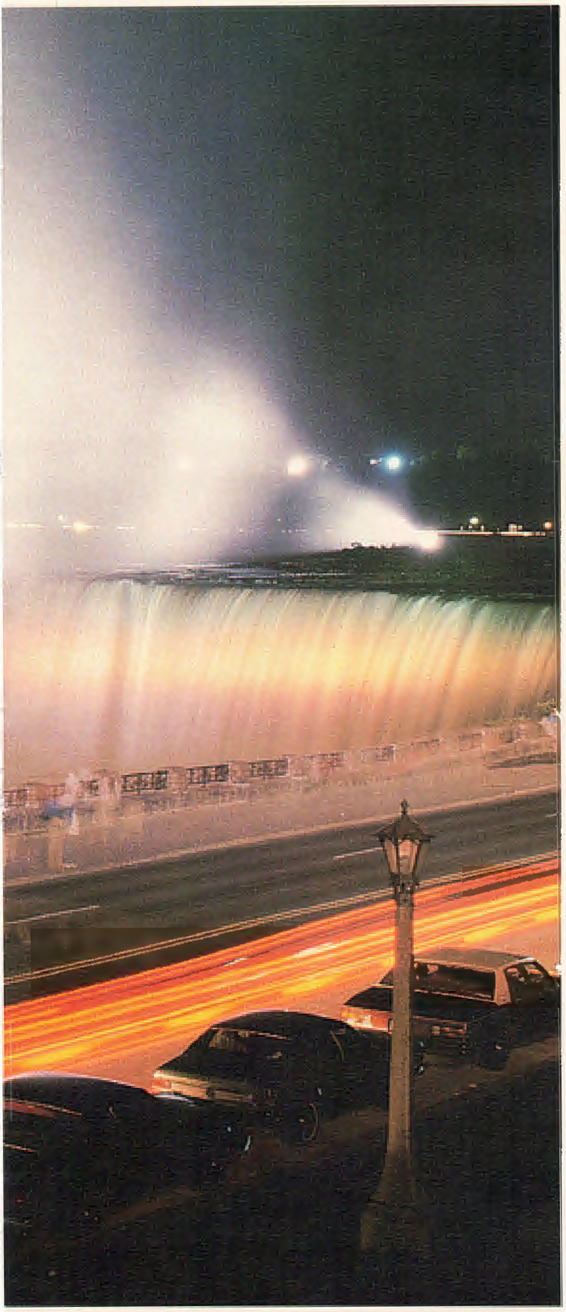
If the median forecast proves to be right, our electricity service may become less reliable around the year 1993. Under the high growth scenario, we could start experiencing supply problems as early as 1990. This could require us to make expensive purchases from neighbouring utilities or to appeal to customers to cut back on their use of electricity. The low load growth forecast would give us more time, until about 2008.

Increasing needs cannot be met simply by wringing more megawatts from Hydro's existing system. To understand why, we'll now take a brief look at these facilities and how they operate.

3. A FLEXIBLE SYSTEM FOR SERVING CUSTOMERS



Although Ontario has vast water resources, hydro-electric generation represents a declining proportion of Hydro's supply resources.



Chapter Three

ONTARIO'S EXISTING ELECTRICITY RESOURCES ARE SHRINKING

LOOKING *at the awesome power of Niagara Falls, it's hard to imagine a problem with our electricity supply. After all, as the Falls aren't going to dry up, how can our electricity supply be shrinking? The answer lies in Ontario's changing electricity system. It was built on the power of falling water. That's why it was called "hydro" electricity, after the Greek word for water. But times have moved on ...*

- Although Ontario has vast water resources, little of it has enough drop or flow to make it suitable for further hydraulic development. New development will be significant, but limited.
- Hydraulic generation now represents a declining proportion of Ontario Hydro's supply resources. We get nearly four times as much of our electricity from other sources as we do from hydraulic, as indicated in Figure 6.
- During their lifespan of 90 years, hydraulic stations need major repairs – from the concrete in the dams to the blades in the turbines.

A Snapshot of Today's Generating System

Today, Ontario Hydro supplies electricity through a highly integrated system that comprises generating facilities, delivery facilities and interconnections with neighbouring utilities in Canada and the United States.

Hydro's generating stations are of three types: hydraulic, "fossil" and nuclear. Fossil fuels include coal, oil and natural gas (all deriving from fossil remains). Both fossil and nuclear stations generate heat to drive turbines. Ontario's nuclear stations use natural uranium in the Canadian-developed CANDU reactor to produce heat from controlled fission, a process that involves splitting uranium atoms by bombarding them with neutrons.

Generating stations are designed to a certain size or installed capacity, measured in megawatts (MW). Some small hydraulic stations have a rated capacity of as little as one megawatt or less. Major nuclear and fossil stations have several generating units providing a total capacity of up to thousands of megawatts ...

- *Hydraulic Generation.* By 1993, Hydro's dependable hydraulic capacity will be some 6,500 MW, provided by 265 generating units in 68 station sites. The unit sizes vary from less than one megawatt up to 130 MW. Even though the total capacity of hydraulic facilities has actually increased by a small amount since the 1960s, they have formed a declining proportion of the system as a whole, which has grown significantly in the intervening period.
- *Fossil Generation.* Hydro has 11,850 MW of fossil-fueled generating capacity, provided by 28 units located at six generating station sites, as well as by a number of small combustion turbine units (CTUs). These 28 units range from 100 MW to 560 MW in capacity.

In the late 1970s and early 1980s some fossil stations were removed from service and mothballed because they were not needed. "Mothballed" plant refers to existing stations which have been taken out of service but can be restarted as needed. Most of this generation has been returned to service.

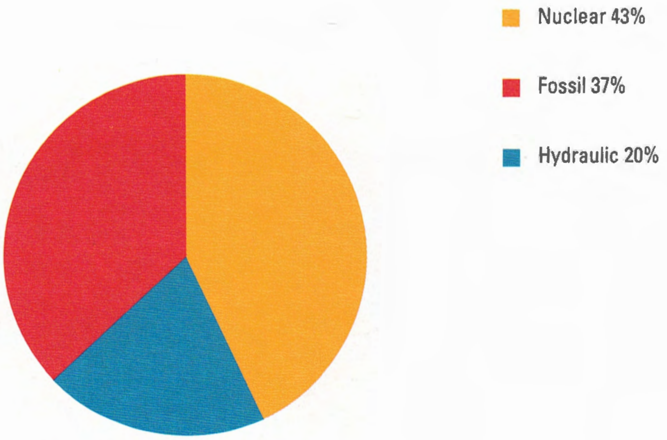
- *Nuclear Generation.* By 1993, there will be 14,150 MW of nuclear capacity in service, provided by the Pickering, Bruce and Darlington generating stations. The nuclear units, which range from about 500 MW to 880 MW in capacity, are all of the CANDU design.

In 1993, Darlington Nuclear Generating Station will be completed. At the moment, Darlington is Hydro's only new generating facility under construction.

Hydro's Delivery Network

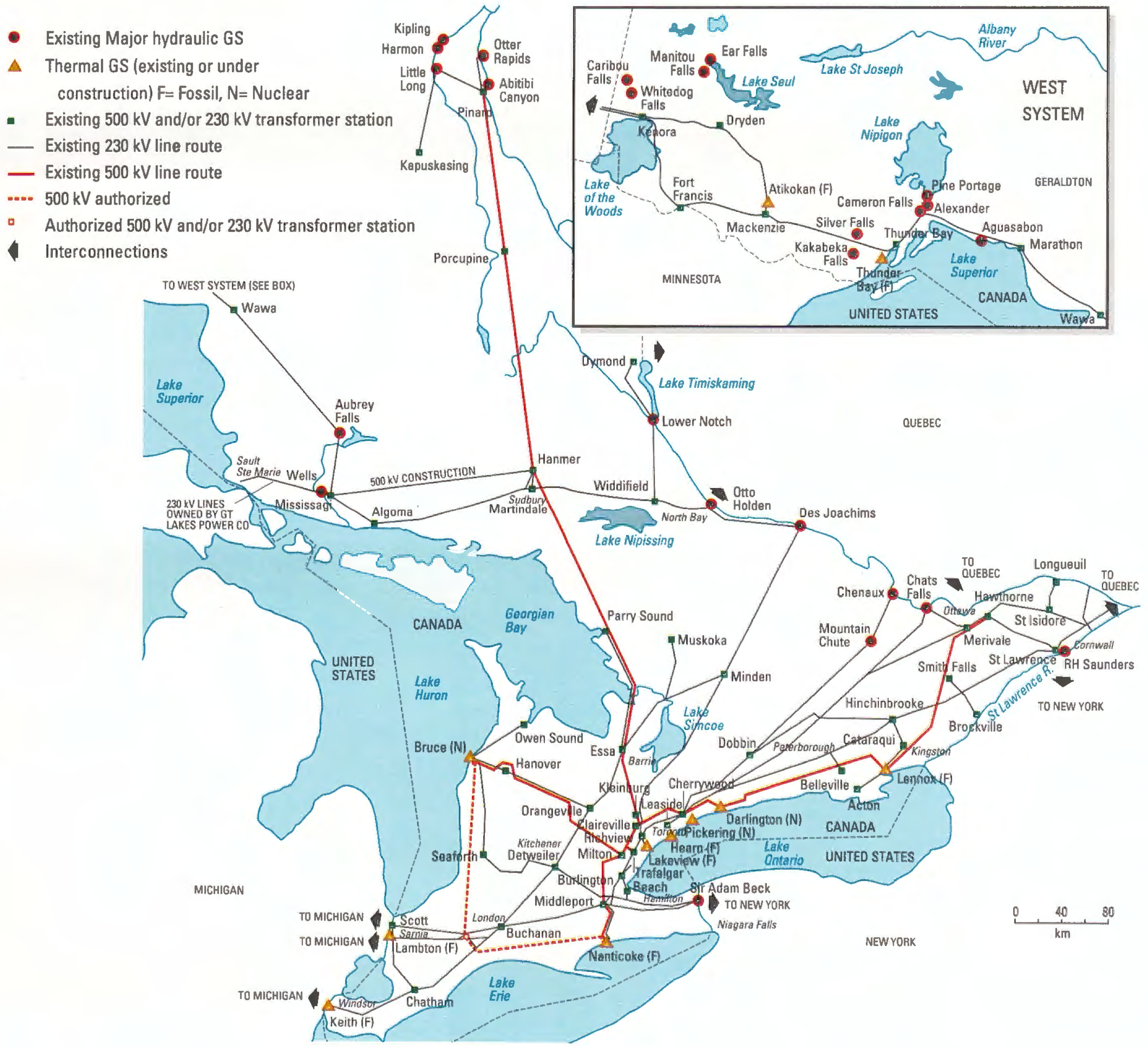
Hydro delivers the power produced by its 79 generating stations through a province-wide transmission and distribution network. The "transmission" component is the high-voltage

Figure 6 **The Hydro System in 1993**



By 1993, the Pickering, Bruce and Darlington nuclear stations will represent about 40% of Hydro's generating system. Fossil stations will account for slightly less, while hydraulic generation will amount to about 20%.

Figure 7 **Ontario Hydro Generation and Transmission System**



Sixty-eight hydraulic stations will be in service by 1993.

Fossil stations are fueled by coal, natural gas or oil.

Darlington is Hydro's only major new generating station.

system that carries electricity over long distances, whereas "distribution" refers to local delivery at lower voltages.

Today's provincial electricity grid consists of integrated 500-kilovolt (kV) and 230-kV networks, with further regional extensions along 115-kV networks. The transmission system also includes transformer stations and other equipment which convert higher voltage levels to lower levels, switch facilities in and out of service, provide voltage regulation and protect equipment.

The delivery system is designed and built to allow Hydro to manage the hourly and daily fluctuations in power flow across the province, including rapidly changing power flow patterns arising from faults, emergencies and other unusual conditions.

The Hydro transmission grid includes interconnections with neighbouring utilities. These interconnections have a number of advantages for Hydro and its customers.

First, they provide a backup in case Hydro runs into generating or transmission problems that would interfere with delivering reliable power to its customers. Second, they allow Hydro to purchase power from outside when this is cheaper than producing it, as well as to sell it when this will benefit Hydro customers. Third, they help resolve power quality problems that Hydro may experience from time to time, such as variability in current frequencies.

Purchases from other utilities are of two types: ad hoc exchanges negotiated on a short-term basis by system operators; and what are termed "firm" purchases, negotiated in advance. Ad hoc transactions are not included in Hydro's long-range supply plans.

Customer Needs – the Major Influence on Operations

When it comes to operating Hydro's supply system, the major influence is customer needs – those rising and falling load patterns created as we use electricity in our daily lives. Because demand fluctuates, it's a lot more efficient to supply electricity using a range of generating methods.

Diversity of fuel type and generating technology can help achieve three objectives: keeping reliability up, keeping costs down, meeting environmental requirements.

The distinctive nature of each generating technology determines the order in which Hydro's different stations are brought into service to meet load fluctuations. Hydro operates with a balanced mix of supply resources because no one resource option is suitable for meeting the entire range of loads – base, intermediate and peaking.

Operating in the Right Sequence

Hydro's major supply technologies are used in several stages. The basic economic rationale for this sequencing is that technologies with the *lowest* variable costs, largely fuel costs, are operated first, while those with the *highest* variable costs are operated last – subject to environmental regulations.

Hydro operators allocate base load hydraulic, then peak load hydraulic, then base load nuclear and finally fossil fuels. The fossil fuels act as "swing" fuels to fill in remaining energy needs.

Future generations will be served by the existing electricity system and a range of alternative resources.

Hydro uses hydraulic capacity to its fullest extent, nuclear capacity to the extent possible and fossil capacity only as necessary. A number of factors, such as transmission constraints, can affect the preferred generation sequence. By 1993 it is projected that Ontario's annual electricity demand will be met in the following proportions:

- 62% from nuclear generation;
- 15% from fossil generation; and
- 23% from hydraulic generation.

These proportions refer to the actual energy we'll be consuming in 1993, rather than the generating capacity figures mentioned earlier.

Aging and Rehabilitation

Hydro has given high priority to its maintenance and rehabilitation program. What works for the family sedan also works for a coal-fired generating station.

There are differences, of course. Generating stations last much longer than your car – hydraulic stations, 90 years, fossil and nuclear stations, 40 years.

That may sound like a long time. Yet many of Hydro's fossil stations are already 20 to 30 years old. And many hydraulic stations date back to the early part of this century!

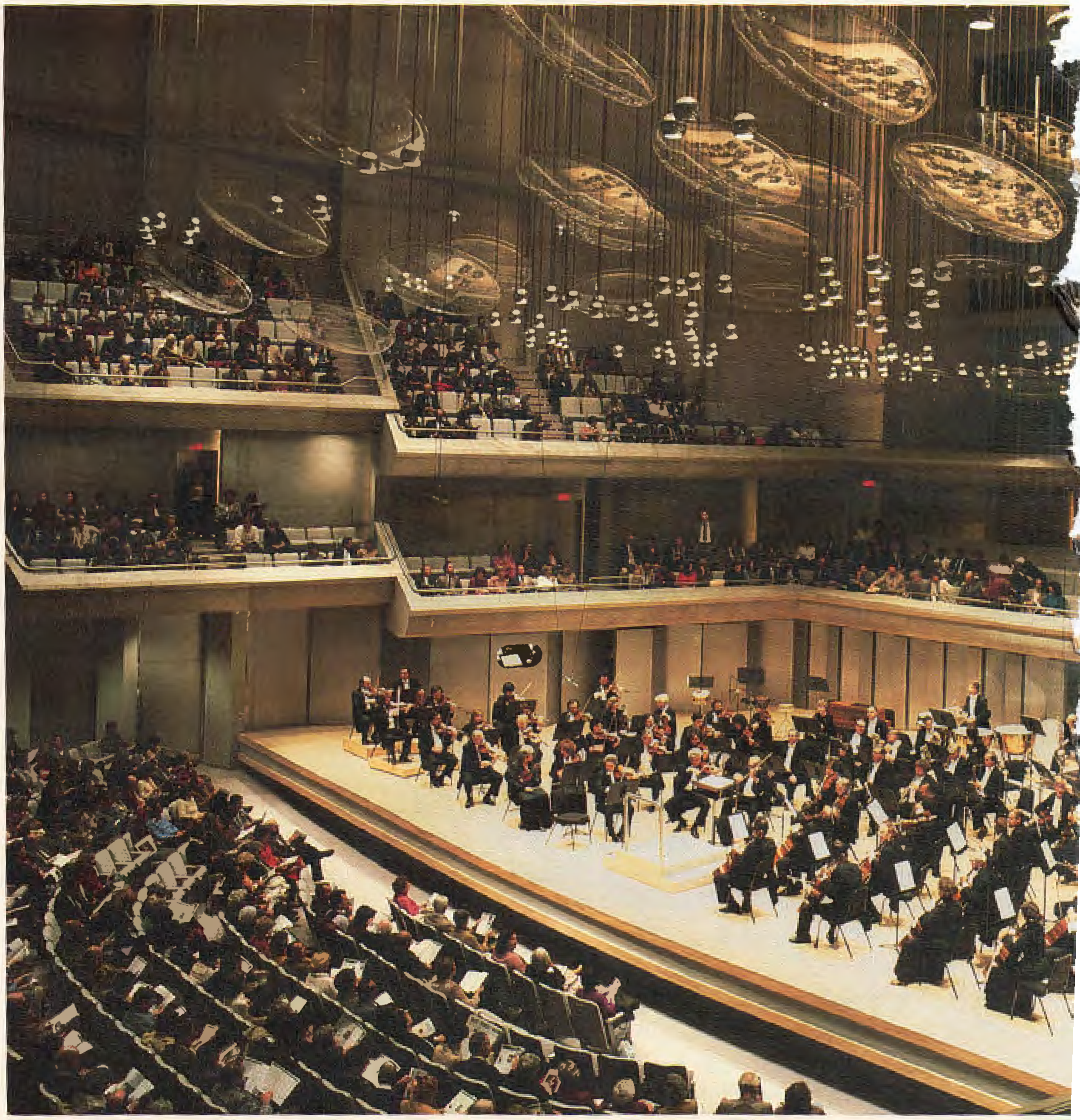
By 2014, over one-quarter of Hydro's existing generating capacity will have reached the end of its planned life cycle. Since customer demand will keep growing through this period, that could mean ...

- A potential shortfall due to growing customer needs ...
- A potential shortfall due to retired generating stations.

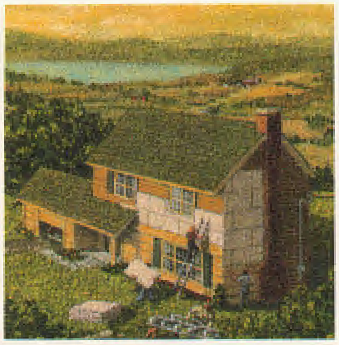
The problems created by the aging process don't mean the existing system is outmoded – far from it. In fact, by the year 2014, today's system will still be supplying two-thirds of Ontario's total energy needs.

It is Hydro's general policy to take all prudent measures that will help postpone the need for major sources of supply – new generating stations. What the maintenance and rehabilitation program can do is postpone that need – as can the range of alternative resources we're about to look at.

4. PRIORITY RESOURCES TO MEET NEEDS



More efficient use of electricity lowers demand and helps postpone building new supply facilities.



Chapter Four

HYDRO

has relied on a range of electricity resources for decades. Some involve programs to influence demand, known as demand management. Others involve going outside the utility, the Hydro system, for alternative sources of supply, such as private power producers. Hence the name – "non-utility generation". What has changed recently is the emphasis on these alternatives. Hydro gives high priority to economic demand management and non-utility generation, in addition to economic hydro-electric development.

New street lighting achieves electricity savings.

A clear set of priorities determines the order in which Hydro selects these options for planning purposes ...

- rehabilitation and maintenance
- demand management
- non-utility generation
- hydraulic development
- major new supply.

Independent Sources of Supply

Ontario Hydro regularly buys electricity from two external sources ...

- private producers, known as "non-utility generators" (NUGs), and
- neighbouring utilities.

In these cases, Hydro acts as the distributor of power to the user, though not as the producer. For one special user group, however, Hydro is neither producer nor supplier ...

This group consists of producers who generate heat, often in the form of steam, then use it for both direct industrial applications and driving turbines to generate electricity. This dual process is known as "cogeneration".

Electricity Supply versus Electricity Services

An increase in some electricity service – like lighting or heating – does not necessarily mean an equivalent increase in the electricity consumed.

In many situations, a certain level of service can be maintained, while the amount of electricity needed is actually reduced. This is a basic aim of demand management. Let's consider two examples ...

- *Street lighting* – Many Ontario municipalities have upgraded their street lighting using more efficient lamps. While they consume less electricity, the new lamps maintain a safe and adequate lighting level. This is an electrical efficiency improvement, one of the most important techniques for achieving load reductions.
- *Recharging vehicle batteries* – As we've noted, customers use much less electricity at night – off peak – than during the day. Hydro offers discounted time-of-use rates for using power at off-peak times ... to carry out routine functions like recharging electrically operated service vehicles.

This has an effect called "load shifting", so named because it shifts a portion of customer load from peak to off-peak times. Though this is different from load reduction, both have the effect of allowing Hydro to plan for less capacity in its supply system.

Alternative Options Must be Economic

All electricity resource options have their cost and all costs must be recovered in customer rates.

Hydro uses a costing technique known as "avoided cost" for judging the full cost of an option. Simply stated, avoided costs are the costs Hydro avoids when electricity needs can be met through non-utility generation, demand management or other alternative options, rather than by building and operating major new sources of supply.

The analysis of avoided costs determines *whether individual demand management programs and non-utility generation projects are economic.* A program or project is considered economic if all the costs involved in its implementation are no more than the avoided cost of the equivalent supply.

Realistic Goals for Priority Options

If we replaced all the lighting in streets, stores and homes with more efficient lamps and all the motors in our factories with more efficient motors, Ontario would save very substantial amounts of electricity. We'd save even more if we turned on equipment only when we needed it and insulated all our electrically heated homes to R2000 standards.

Are these desirable goals realistic?

All the inefficient bulbs in the province represent large *potential* for an improvement program. But many barriers stand in the way of realizing that potential. Two of the most important are lack of customer information about savings opportunities and the costs involved in buying new equipment.

The Concept of Avoided Cost

Avoided costing is a method that allows Ontario Hydro to integrate demand management and non-utility generation opportunities with the utility's future supply plans. By calculating Hydro's avoided costs, planners are able to compare the benefits of various demand management and non-utility generation projects with supply options. Avoided costs have to take into account the timing of delivery, reliability, and the life-cycle and location of particular options.

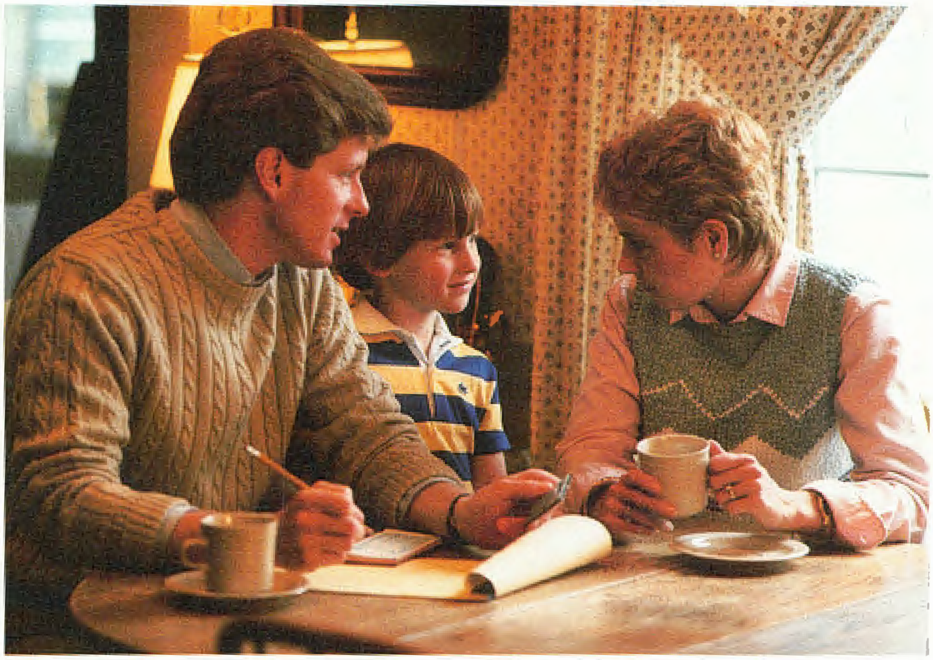
A primary objective of Ontario Hydro's integrated planning process is the maintenance of Ontario's electricity supply and price advantages for the future benefit of all customers. Many factors will help determine Hydro's success in doing so, but chief among them will be its success in developing the full economic potential of all available options.

In evaluating demand management programs, Hydro applies a total customer cost test. Total customer cost is defined as the combined total of all expenditures made by both Hydro and its customers under a particular program, and which have the effect of reducing demand by some estimated amount.

If these combined expenditures amount to less than the corresponding avoided cost, then the program is economic. The cost of mitigating and preventing social and environmental effects of supply is reflected in Hydro's calculation of avoided cost.

In addition to helping estimate the potential value of non-utility generation and demand management, avoided cost calculations are used to evaluate a number of other options, such as the potential for new hydraulic generation.

Appropriate avoided costs will be examined by the Environmental Assessment Board in its review of the Demand/Supply Plan.



Everyone can find ways to save electricity.

All other alternative resource options face their own particular barriers.

For non-utility generation, these barriers may include a poor investment climate or lack of tax advantages. New hydraulic development faces technical, financial and environmental constraints.

Hydro's activities in these areas have two major aims ...

- First, to set realistic, attainable levels for the contributions that can be made by demand management, non-utility generation and new hydraulic development.
- Second, to undertake the incentive, information and development programs necessary to make sure these levels are realized.

Hydro's Demand Management Plan

Demand management includes activities undertaken by Hydro to help customers conserve electricity and use electricity more efficiently. Hydro's demand management programs place it among the leading North American utilities active in this area.

Reducing demand means Hydro may be able to postpone building new supply facilities. Demand management also reduces the consumption of fuels such as uranium, coal and oil, which helps reduce the environmental effects of power generation.

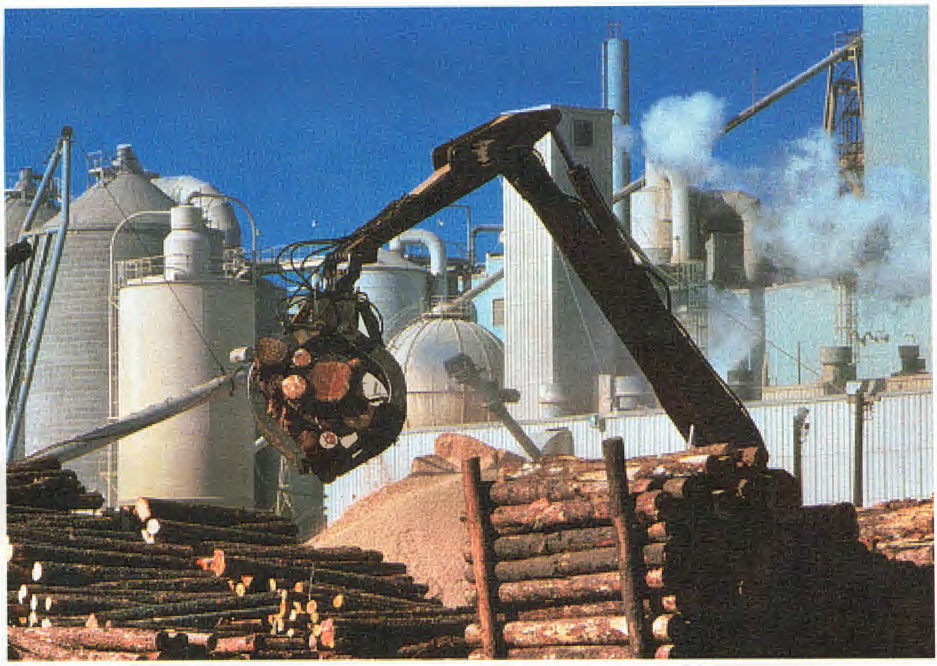
The single most important vehicle for reducing electricity demand lies in improving the efficiency of electrical use. The basic aim of electrical efficiency improvements is to maintain a certain level of service while using less electricity.

Such reductions can be achieved in two different ways. One involves the replacement of older, less efficient equipment with *new* equipment or technologies that operate at higher efficiencies. The other avenue for achieving improvements concerns how customers use *existing* equipment. Here the role of demand management programs is to advise customers how to make more efficient use of their electrical equipment.

What Opportunities Exist for Demand Management?

- *Electrical efficiency improvements.* The most important efficiency-improving technologies include improved insulation levels in new and existing houses; heat pumps; improved heating and ventilation equipment in commercial buildings; high efficiency lighting; and high efficiency and variable speed motors and drives.
- *Load shifting.* There are several ways to shift customer demand from peak to non-peak periods. Time-of-use rates give large industrial customers an incentive to shift their electricity use away from peak demand periods. With a customer's permission, a utility can also control demand directly by means of devices that shut off water heaters for selected periods of time.
- *Interruptible contracts.* Hydro offers capacity interruptible contracts for those customers willing to trade reliability for lower electricity bills. Under an interruptible contract customers agree to reduce their load to a stipulated level at certain times on request from Ontario Hydro.

In total, Hydro's Demand Management Plan calls for a projected reduction in the need to supply over 3,500 MW of peak demand by the year 2000 ... and of almost 5,500 MW by 2014.



Some customers, such as pulp and paper plants, produce their own electricity, an example of non-utility generation.

Hydro's Non-utility Generation Plan

Non-utility generation is electrical generation owned and operated by producers other than Ontario Hydro. Non-utility generators include private and municipal utilities, and private power producers. The electricity they generate may be either purchased outright by Hydro for distribution to its customers, or else used to meet the producer's own electricity needs.

Non-utility generation which is sold to Hydro is known as "purchase" generation. The NUG generators involved are interconnected with the province-wide transmission and distribution network. Like purchases from other utilities, purchase generation is considered to be a supply resource.

On the other hand, non-utility generation which provides electricity to meet the producer's own needs or is directly purchased by a customer other than Hydro is referred to as "load displacement" generation. It is so termed because such generation displaces load which Hydro would otherwise have been responsible for supplying.

Eleven NUG projects totalling 172 MW are under construction. Developers of another 23 facilities totalling 216 MW have indicated they are committed to construction. New additions by 2014 will amount to about 2,100 MW, and there will likely be a total of about 3,500 MW in existence by that time. In order to provide encouragement to the industry, Hydro plans to allocate about $40 million annually for financial assistance, most of which will be applied as low-interest loans.

Hydro's Hydraulic Generation Plan

Hydraulic projects are civil engineering works with large capital requirements. However, they are inexpensive to operate, have a long life expectancy and require little maintenance. Hydraulic generation has high Ontario content in materials and contributes to local economic development.

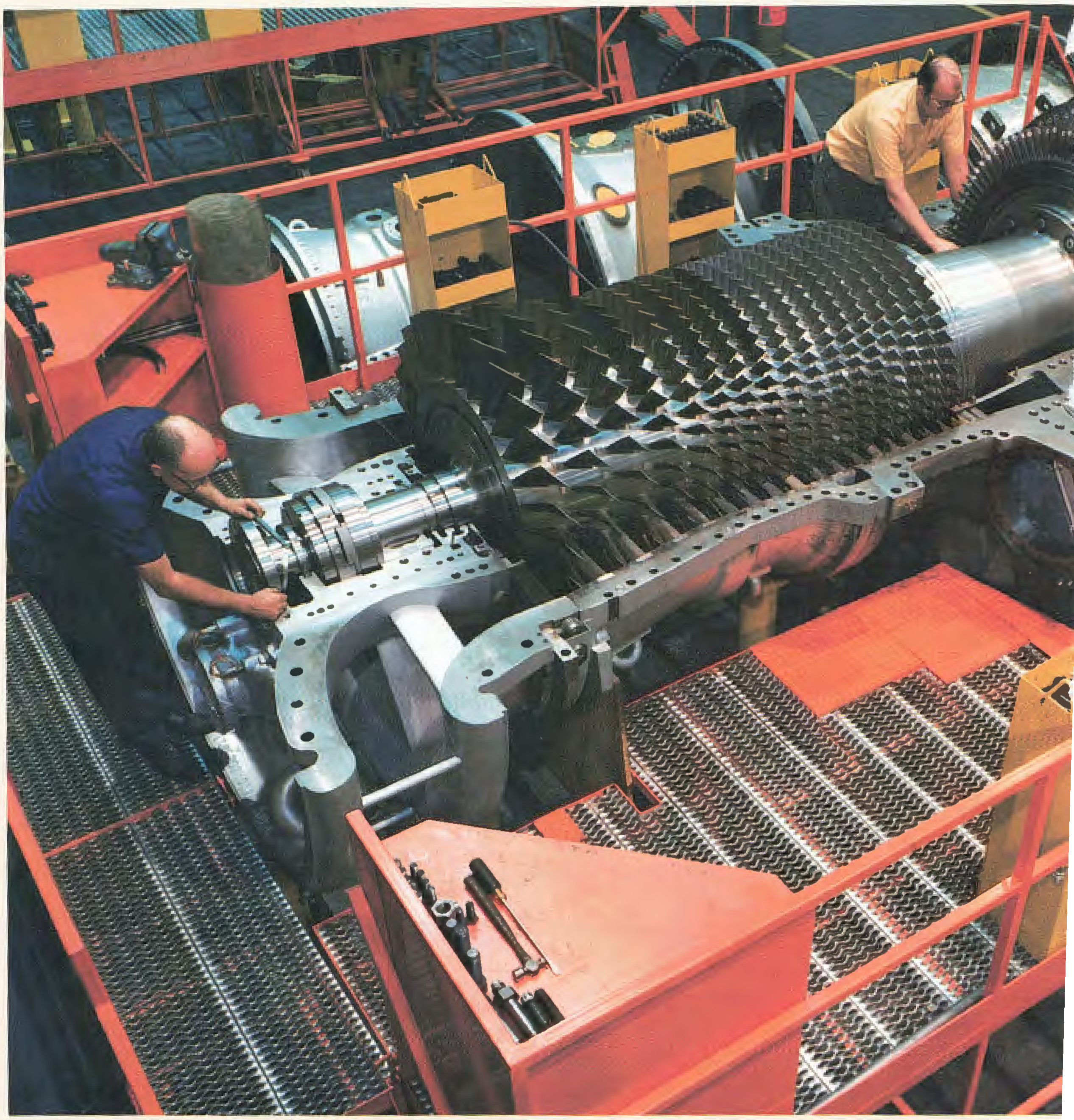
Although hydraulic generation does not produce any environmentally hazardous emissions, development of a site does have environmental effects. Each hydraulic development will be subject to an environmental assessment when approval for the project is sought.

While existing hydraulic generation is Ontario's lowest cost source of electricity, studies show the cost of new projects to be considerably higher, since the most economic sites have already been developed.

The scarcity of economic, undeveloped sites will limit the role that further hydraulic generation can play in Ontario. However, the Hydraulic Plan demonstrates the high priority Hydro gives to the orderly development of hydraulic sites.

The Hydraulic Plan comprises 18 sites – nine new sites, three redevelopments and six extensions. Over the next 27 years, about 3,000 MW of capacity will be added, which represents roughly 11% of the total system capacity. The total capital cost of all 18 sites without interest is estimated at $4.9 billion.

5. CHOOSING THE BEST MAJOR SUPPLY OPTIONS



A mix of options, including combustion turbine units, is needed to meet Ontario's future electricity needs.

Chapter Five

ACHIEVING RELIABLE SUPPLY

WE'VE

seen that a significant contribution will be made to Ontario's future electricity needs by several different sources ... The Existing Supply System • The Demand Management Plan • The Non-Utility Generation Plan • The Hydraulic Generation Plan. The combined contribution of all these resources will amount to about 27,800 MW ... yet this will leave a shortfall of 12,200 MW by 2014, to be made up by major supply options.

In a busy city hospital ...

... or an isolated farm house, reliable electricity service is vital.

Reliability and Reserve Margin

The total contribution of all demand and supply resource options must satisfy the peak requirements forecast by Hydro through the 25-year planning period.

Even if we knew exactly how much electricity Ontario customers were going to need from one year to the next, we couldn't just build enough supply to meet those needs and no more. That amount of electricity – to meet what we call the "planning firm load" – would only be sufficient in a perfect world ... where generating stations ran all the time, without any planned or unplanned service interruptions or "outages".

To make the supply system truly *reliable*, we have to make an allowance for a number of factors:

- Normal equipment breakdowns
- Occasional major repairs and maintenance
- Local air quality considerations, water levels and flows, transmission considerations, coal freezing
- Unseasonable weather, unexpected economic growth and other developments pushing up load growth
- Labour disputes affecting fuel supply, transportation
- Delays to the startup of new facilities.

So Hydro's supply capability must include an insurance factor we call the "reserve margin".

Ontario Hydro's reserve margin for planning purposes is 24% of the planning firm load. By 1993, the total capacity of Hydro's system will be 32,500 MW. The planned reserve margin will amount to 6,300 MW. The difference between these two figures – 26,200 MW – is called the load-meeting capability of the system. This is the peak load that can be reliably supplied to the customer by the existing system.

Ontario Hydro's Review of Options

From 1984 to 1989, Ontario Hydro conducted a number of studies on Ontario's future electricity needs.

Contributions were made from many different sources:

- Consultation meetings with provincial organizations, community leaders and municipal utilities
- Public attitude research
- Public hearings and reviews, including the Ontario Legislature's Select Committee on Energy, the Ontario Nuclear Cost Inquiry and the Ontario Nuclear Safety Review.

These reviews identified a number of supply options as unsuitable at this time for development by Hydro in meeting future needs, among them solar, wind, wood, peat, waste and fuel cells.

Despite their unsuitability as major supply options for Ontario Hydro, some of these options are suitable for development by non-utility generators or in other situations where they have advantages, particularly where electricity from the Hydro grid is not available.

Hydro will continue to do research and development on generation concepts which have promising applications. Hydro is also keeping abreast of research and development by others and is ready to respond if a major technological breakthrough occurs.

Emphasis on Integrated Planning

Hydro takes an integrated and comprehensive approach to its consideration of all these economic electricity resource options. This approach is reflected in Hydro's Demand/Supply Planning Strategy (DSPS), which was approved by the Board of Directors in March, 1989. The strategy contains a set of guidelines for developing long-range plans. Hydro expects both demand management and outside purchases of electricity to make important contributions to meeting future requirements.

The Importance of Safety & Environment

As environmental concerns have grown, Hydro has increased its efforts to protect both natural habitats and the social environment.

Hydro's companion "Environmental Analysis" report provides further information on relevent environmental issues.

It is Hydro's environmental policy to manage all its activities which affect the environment so that the Ontario community receives the greatest overall net benefit in the long term.

In our Corporate Strategy for the 1990s, Hydro set out its commitment to sustainable development. As a consequence, our Board of Directors announced an environmental strategy in 1988 which combines economic and environmental goals:

> ***"Given that the Province's long-term economic prosperity depends upon the ability to minimize ecological costs, Ontario Hydro will develop and manage its activities and facilities in such a way as to sustain the environmental base."***

Hydro's commitment to environmental standards extends to safety concerns as well, particularly in the area of nuclear power. One of Hydro's basic operating goals is to

Planning Criteria

The criteria for evaluating and selecting options were developed in Hydro's Demand/Supply Planning Strategy:

- Customer satisfaction
- Reliability standards
- Worker and public safety requirements and standards
- Environmental requirements and standards
- Low cost of electricity service
- Social acceptance
- Technical soundness
- Flexibility
- Resource preferences
- Diversity
- Resource smoothing
- Environmental characteristics, in addition to requirements and standards
- Public safety characteristics, in addition to requirements and standards
- Economic impact
- Other social considerations.

minimize health risks posed by nuclear generation to either Hydro workers or members of the public.

Social Considerations

The guidelines developed in Hydro's Demand/Supply Planning Strategy incorporate the results of extensive public consultation, during which Hydro gained a better understanding of public values, concerns and expectations.

The extent to which Hydro's plans, as based on these guidelines, prove to be socially acceptable will likely depend on:

- How well Hydro takes into account changing social values related, among other things, to Hydro's environmental performance and maximum achievement of priority resources – demand management, NUGs, hydraulic generation and station rehabilitaton; and
- The choice of supply options, which is both a province-wide and local concern.

Social acceptance of plans will be evaluated through the environmental assessment process, which will provide opportunities for public comment. Social acceptance and other social considerations will also be an important factor in siting decisions.

Major Supply Options Suitable for Plans

Hydro examined a large number of major supply options for inclusion in its plans. While many were considered acceptable, several were chosen because they were judged to be particularly suitable for meeting customer needs.

Some of these options were fossil, each involving a different conversion process. The other two were the CANDU nuclear option and the Manitoba Hydro firm purchase.

Monitoring and controlling emissions is part of Hydro's environmental protection program.

Acid Gas Control

A major environmental challenge in planning the electricity system is acid gas emissions from the burning of fossil fuels.

Fossil-fueled generating stations emit sulphur dioxide (SO_2) and nitrogen oxides (NO_x), gases which contribute to acid rain. In the early 1980s, total acid gas emissions from all of Hydro's fossil stations averaged about 500,000 tonnes a year.

Hydro reduces acid gas emissions by reducing the use of coal-fired generation; by using fuel with lower sulphur content; and by using emission control technologies.

Through the period to 1994, Hydro is required by legislation to reduce total acid gas emissions by about 50%, to a limit of 215,000 tonnes a year in 1994.

These acid gas emission ceilings limit the amount of energy that can be produced at existing fossil stations. Acid gas control devices such as SO_2 scrubbers and combustion process modifications to reduce NO_x emissions will have to be fitted to existing fossil plants to permit their continued operation in the 1990s and beyond. Other emission and particulate limits may affect the operating conditions of individual fossil-fueled stations as well.

Purchase Options

Because of uncertainties in the American utility picture and high purchase costs, Ontario Hydro cannot rely on the U.S. for a reliable and economic supply of power.

In 1988, Hydro-Québec made an offer to Ontario Hydro of 2,000 MW to run from 1998 to 2023. Hydro-Québec has been informed that, on economic grounds, the offer is not acceptable. Discussions are continuing, focussing on smaller purchases of a shorter duration that may be more attractive. Hence, a purchase from Hydro-Québec is not included for plan analysis at this time.

Ontario Hydro has agreed to purchase 1,000 MW of power from Manitoba Hydro over a period of about 20 years. This purchase is desirable for several reasons: low cost, improved electrical reliability in Northern Ontario and the use of a renewable resource – falling water.

Because agreement has been reached, the Manitoba purchase is included in all plans for analysis.

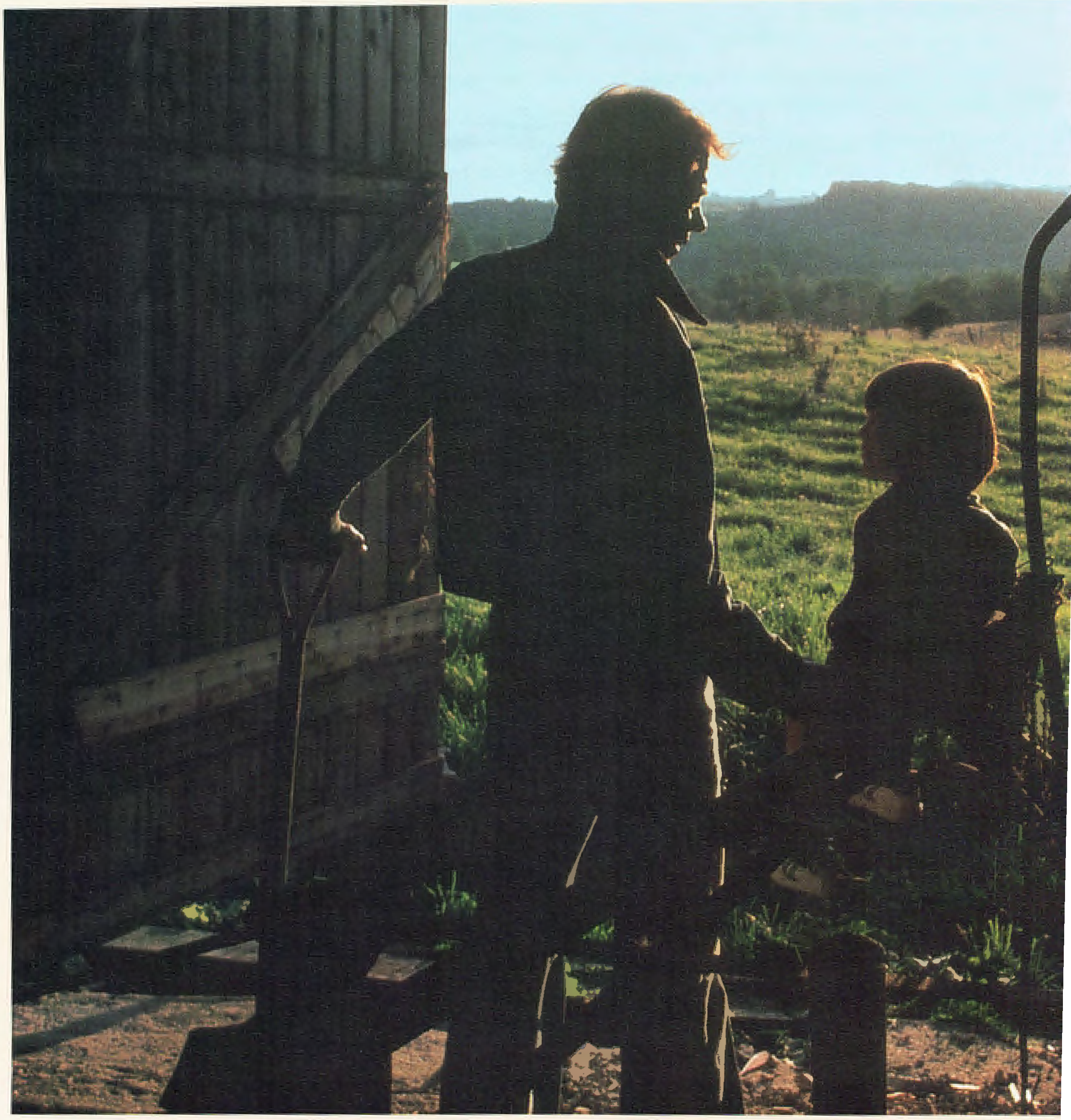
As environmental concerns have grown, Hydro has increased its efforts to protect both natural habitats and the social environment.

Fossil Conversion Processes

The main conversion processes for fossil fuels considered in Hydro's planning exercise include conventional steam cycle (CSC), combustion turbine units (CTUs), combined cycle (CC), and phased and unphased integrated gasification combined cycle (IGCC).

- *Conventional Steam Cycle.* In the conventional steam cycle, fuel in the form of coal, gas or oil is fed to a boiler. Combustion takes place in the boiler as air from fans is mixed with fuel in the burners. Heat energy is recovered within the boiler through various kinds of water- and steam-cooled tubes and converted to high pressure superheated steam. The high pressure steam spins a turbine which drives a generator.
- *Combustion Turbine Units.* CTUs may burn natural gas or oil. Fuel is usually fed directly to the combustion chamber along with high pressure air injected from a compressor. The fuel and air are burned, producing hot gases which expand through the turbine blades causing the turbine to rotate at high speed. The turbine drives a conventional generator which generates electricity for delivery to the grid.
- *Combined Cycle.* CCs are made up of combustion turbine units in combination with appropriately sized heat recovery steam generators. As with CTUs, natural gas or oil is the primary fuel for CCs. The steam generator converts the heat of the hot exhaust gas from the CTUs into steam, which is used to drive a conventional steam turbine generator.
- *Integrated Gasification Combined Cycle.* IGCC takes the CC conversion process one step further by adding a coal gasification plant to permit the use of lower cost coal as its primary fuel. The IGCC conversion process integrates several proven processes, such as combined cycle and coal gasification, into a single high efficiency, "clean" fossil option.

6. FINDING A BALANCED SOLUTION



The resources we develop today will serve not only us, but our children and our children's children.

Chapter Six

AFTER

acceptable supply options are identified, the next crucial step in the electricity planning process is the formulation of potential supply plans – combinations of supply options called cases.

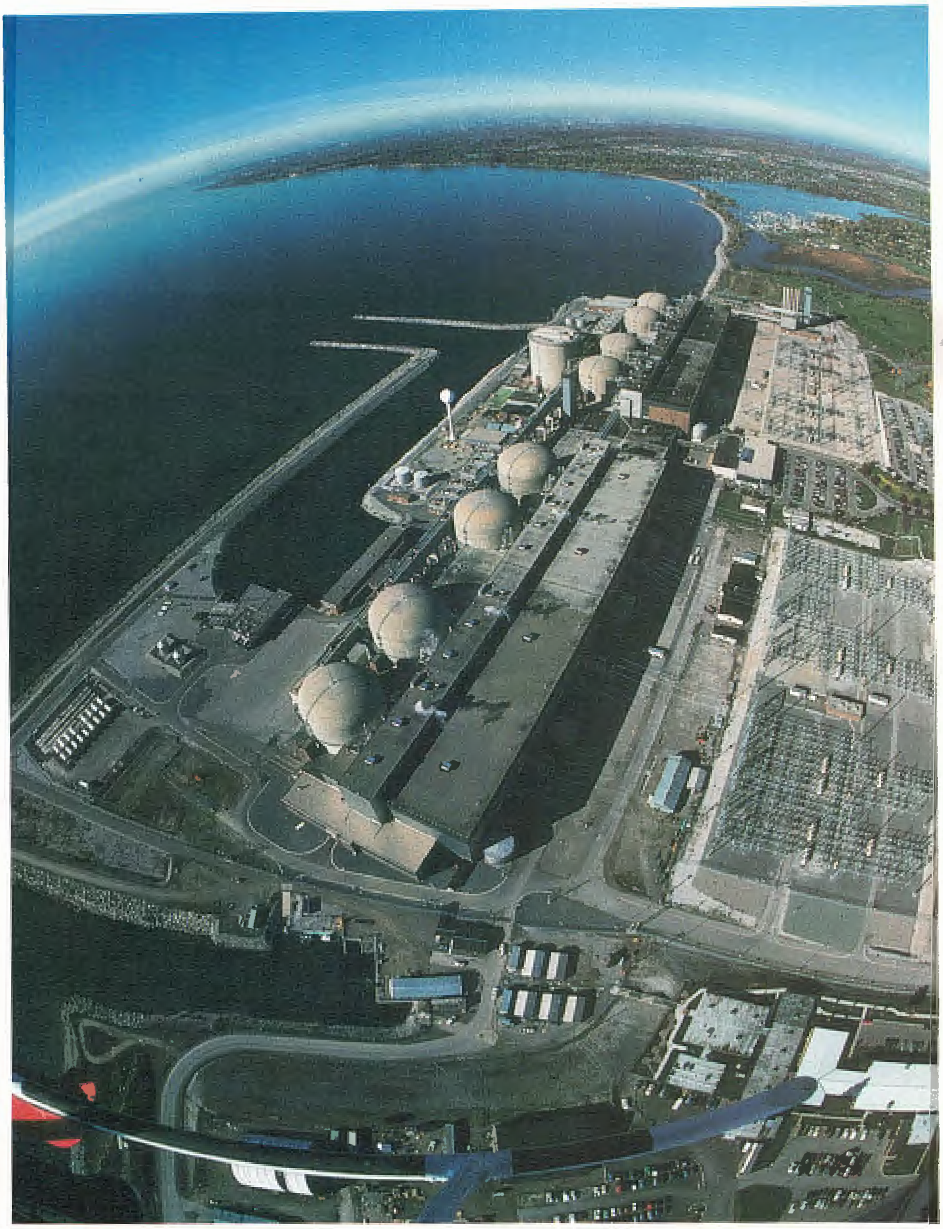
This step involves combining supply options in various ways and testing them against a range of planning criteria. Hydro developed over 40 cases for analysis. Computer models were used to simulate each case, showing how new major supply options might work with the existing system and the Demand Management, Non-Utility Generation and Hydro-electric Generation Plans.

Natural gas is used primarily to meet peak electricity needs.

The information resulting from these simulations was then analyzed. Some cases were dropped because they produced poor results or did not meet the primary criteria. The remaining cases were evaluated and revised, and five cases were selected for detailed study. These five remaining cases were numbers 15, 22, 23, 24 and 26.

The five cases all performed well in terms of reliability, safety and technical soundness. After looking at a broader range of criteria (see list of planning criteria on p. 35.), we determined that two cases were unacceptable on the basis of cost and other criteria and that three cases should stand as Candidate Supply Plans. The three Candidate Supply Plans were Plans 15, 22, and 24.

All cases include the purchase of electricity from Manitoba Hydro. The purchase starts in 1998 at 200 MW and grows to 1,000 MW by 2003.



Pickering nuclear generating station has supplied a significant portion of Ontario's electricity needs since the early 1970s.

To help reduce electricity demand, Hydro encourages the use of home insulation.

Ontario Hydro has agreed to make a major electricity purchase from Manitoba Hydro.

Five Selected Cases ... Three Candidate Plans

Case 15 – This case is designed to achieve both low environmental impact and low cost. A mix of base load nuclear and peaking fossil options is used to achieve low acid gas and greenhouse emissions, low cost, flexibility and diversity. Intermediate load is met by existing fossil stations retrofitted with emission controls as required. **Case 15 was judged to satisfy the planning criteria.**

Case 22 – This case is designed to fall between Case 15 and Case 23. It illustrates the effect of using more nuclear generation and less fossil generation. **Case 22 was judged to satisfy the planning criteria.**

Case 23 – This case is designed to minimize greenhouse gas emissions. Nuclear stations meet the base load and some of the intermediate load requirements. Existing fossil generation aids in the intermediate and peaking role and a minimum of new peaking fossil is added. **Case 23 was judged to be unacceptable because of its high cost, high reliance on nuclear generation and vulnerability to approval delays.**

Case 24 – This case is designed to fall between Case 15 and Case 26. It illustrates the effect of using a conventional steam cycle (CSC) coal station for the second major addition of base load plant. CANDU nuclear provides the other base load requirements. **Case 24 was judged to satisfy the planning criteria.**

Case 26 – This case is designed to minimize concerns about nuclear safety and radioactive materials management. Thus, no new nuclear additions are made. CSC coal-fueled generation meets base load requirements and gas-fired CTUs meet peaking needs. Existing fossil generation meets intermediate requirements. **Case 26 was judged to be unacceptable because of its high cost, the environmental effects of large amounts of fossil generation and vulnerability to approval delays.**

Alternative cases 15, 22 and 24 were therefore selected as candidate major supply plans.

PROPOSING PLAN 15

PLAN COSTS

Plan 15 has the lowest overall cost. Using the period 1994 to 2014 as a basis of comparison, Plan 22 (higher nuclear) is 10% higher in cost and Plan 24 (higher fossil) is 5% higher.

ACID GAS EMISSIONS

Plan 22 has the lowest acid gas emissions. Plan 15 has the next lowest, and Plan 24 has the highest. From 2010 to 2014, the annual average emissions for median forecast Plan 22 is 90,000 tonnes, Plan 15 is 135,000 tonnes and Plan 24 is 170,000 tonnes. The flexibility to meet tighter regulations is highest for Plan 22 and lowest for Plan 24.

CO_2 EMISSIONS

The illustrative target considered by the provincial ministers corresponds to 24 million tonnes per year for Ontario Hydro by 2005. Plan 22 has the lowest CO_2 emissions and meets the target for lower and median and almost meets it for the upper. Plan 15 meets the target for lower and median forecasts, and meets the upper target, except for the period from 2005 to 2009. Plan 24 does not meet the illustrative target for all load forecasts.

RADIOACTIVITY

There is continuing public concern over nuclear safety and radioactive waste disposal. Plan 22 has the most new nuclear stations and Plan 24 has the least.

DIVERSITY

There are no major differences in diversity between the existing system and the future system with any of the three Plans.

OPTION MIX

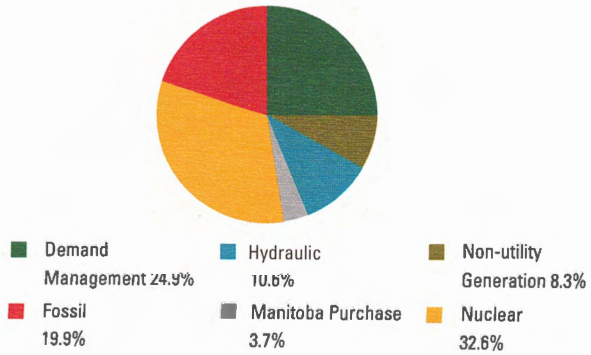


Figure 8

SELECTION OF THE PROPOSED MAJOR SUPPLY PLAN

None of the three Candidate Major Supply Plans is best in all respects. Each represents a blend of advantages and disadvantages. The major differences among the three plans are in new major supply. • While Hydro considers all three Candidate Plans to be acceptable, only one of the three is put forward as Hydro's Proposed Major Supply Plan. • Plan 15 is proposed because it offers good environmental characteristics, good diversity, good flexibility and the lowest cost. • The proposed plan calls for ten nuclear units at three stations and 32 gas-fired combustion turbine units located at four stations over a 25-year period. The number of units could vary, depending on electricity demand. These major supply facilities are part of an overall balanced plan whose other components are Hydro's plans for rehabilitation, demand management, non-utility generation, new hydraulic development and outside purchases.

THE ACTION PLAN

Demand/Supply Plan 15 includes major supply proposals, as well as Hydro's associated plans for rehabilitation, demand management, NUGs and hydraulic development. • In order to implement all these component plans, Hydro has developed an Action Plan which provides a detailed five-year work schedule. • As indicated in Figure 9, the Action Plan phases in the engineering, environmental and construction aspects of the various plan projects. The timing of the projects is determined by the nature of each project, the type of approvals needed and the siting involved. • The purpose of the Action Plan is to ensure coordination, public involvement and balance among the various elements of the Demand/Supply Plan.

WHAT HYDRO PROPOSES TO DO OVER THE NEXT FIVE YEARS

Figure 9

Option	Action	Timing
Demand Management Plan	Implement with High Priority	On going
NUG Plan	Implement with High Priority	On going
Rehabilitation Plan	Implement with High Priority	On going

Option	Capacity MW	Start Preparatory Work	Submit EA	First Unit in Service Date (Median Forecast)
Manitoba Purchase (Independent of Load Growth)	1000	–	–	1998
Associated Transmission	1500	Underway	1991	1999
Hydraulic Generation Plan (Independent of Load Forecast)				
Little Jackfish	132	Underway	Underway	1996
Lake Gibson	5	Underway	1990	1992
Big Chute	10	Underway	1990	1993
Kipling	68	Underway	1990	1994
Smoky Falls	182	Underway	1990	1995
Harmon	68	Underway	1990	1995
Little Long	61	Underway	1990	1996
Niagara	550	Underway	1991	1998
Canyon/Otter/Nine Mile	932	1991	1994	2000
Major Supply Plan				
CTU/NC A	672	Underway	1990	–
CTU/NC B	672	Underway	1991	–
CANDU Nuclear A	3524	1990	1991	2003
CTU/IGCC A	2016	1990	1992	2002
CTU/CC A	1008	1994	1996	2001
CANDU Nuclear B	3524	1994	1996	2009

YOUR CHOICES

Our goal in this overview and our other publications is to provide you with the information you need to make wise choices as a customer ... • In presenting our case for Plan 15, Hydro is proposing that Ontario make a broad range of commitments, including major new generating stations employing fossil and nuclear technologies. • Some tough decisions, with long-term implications, need to be made. The generating stations we build will serve not only us, but our children and our children's children. • In the wider context, Hydro's commitment includes much else – the whole range of electricity resources represented by demand management, non-utility generation, hydraulic development, outside purchases and rehabilitation. The Proposed Supply Plan has to be judged in this light.

THE BALANCE

Ontario's electricity system is now and will continue to be one of the most diversified in the world. Many other public utilities in North America and Europe, faced with similar strains on their ability to meet customer needs, are heavily dependent on a single option – be it hydro-electric, coal or nuclear. • Ontarians are more fortunate in this respect. We have ready access not only to falling water, to uranium, to coal, but to outside sources of purchased power ... and to the initiative of all those people who have lent their support to priority resources like demand management and non-utility generation.

AN OPEN PROCESS

No electricity plan can be all things to all people. • Every decision to increase reliability or lower cost or better environmental guidelines means a trade-off. • What we can hope to achieve is balance. Balance within the Proposed Major Supply Plan, balance across the range of options and resources included in the Demand/Supply Plan as a whole. • This balance of resources is not static. Changing social, economic and technological forces mean electricity planning must be an open, dynamic and continuous process. • Most people would agree that balance is a good thing. Whether Hydro's proposed Demand/Supply Plan has struck the right balance is a question that will stir public debate. This debate will take many forms, official and unofficial, as Ontarians come to grips with the challenges of their electricity future.

ABOUT ELECTRICITY – A GLOSSARY

While many of the terms explained below are defined in the main text, we thought it would be useful to bring them together in one place for ease of reference. Terms marked with an asterisk (*) within definitions are defined elsewhere in the glossary.

Acid gases – nitrogen oxides (NO_x) and sulphur dioxide (SO_2) gases are produced when coal, oil and natural gas are burned to generate electricity. These gases react in the earth's atmosphere, creating products that contribute to "acid rain", which can damage lakes, vegetation, crops and buildings.

Atomic Energy Control Board (AECB) – the federal authority that regulates, inspects and licenses all nuclear generating stations in Canada. Ontario Hydro must adhere to rigorous environmental and safety guidelines set by the AECB concerning the design, operation and decommissioning* of its nuclear stations at Bruce, Pickering and Darlington. Distinct from Atomic Energy of Canada Limited (AECL), a federal agency involved in various commercial applications of nuclear energy.

Avoided costs – costs "avoided" by Hydro when an option such as a demand management* program replaces electricity that would otherwise have had to be supplied by Hydro's generating facilities. Avoided cost calculations determine how much Hydro can pay for these options.

Bandwidth forecast – Hydro faces uncertainties in predicting how much electricity customers will use in the future. It recognizes this uncertainty by projecting a range or bandwidth rather than a single figure. It is assumed there is an 80% chance that electricity consumption will fall within this bandwidth.

CANDU – a Canadian-designed nuclear reactor. The name stands for "CANadian Deuterium Uranium" steam generating system. All nuclear generating stations produce steam from atomic fission to drive turbines and make electricity. CANDU uses deuterium, "heavy water", rather than ordinary light water, as an essential component of the reactor. CANDU also uses natural rather than enriched uranium as fuel.

Capacity – a measure used to define the electrical output potential of a generating unit, station or the entire province-wide system. Capacity is expressed in units of electrical power, usually megawatts or gigawatts (see "units of measure"). In the next 25 years, the capacity of Hydro's generating system will have to expand by many gigawatts to accommodate expected growth in customer needs.

Coal gasification – a chemical process which converts coal to a gaseous fuel suitable for burning in fossil generating stations.

Cogeneration – a process that generates both electricity and useful heat, usually in the form of steam, for large-scale industrial applications such as pulp and paper treatment.

Decommissioning – the permanent closure and dismantling of a generating facility.

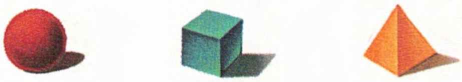
Demand – the amount of electricity that must be generated to meet all customer needs, as well as delivery losses (see "transmission"). "Demand" and "load"* are often used interchangeably.

Demand management – a set of programs and measures undertaken by electrical utilities to influence the amount and timing of customer demand for electricity. Some programs (like electrical efficiency improvements*) are designed to reduce demand. Others (like time-of-use rates*) are designed to shift consumption from peak to off-peak periods.

Dispatch sequence – the order in which generating stations are operated. This order is determined by the need to keep operating costs low while meeting environmental regulations.

Diversity – the extent to which an electricity system can call on a range of generating options*. Ontario Hydro operates a highly diversified system.

Environmental Assessment Board (EAB) – an independent tribunal, the EAB conducts hearings on projects such as the construction of generating stations for which approval is required under legislation such as the *Environmental Assessment*



Act. Following a public hearing, the Board issues a decision as to whether the project should be approved.

Electrical efficiency improvements (EEI) – measures designed to reduce the consumption of electricity while maintaining a given level of service. For example, a less efficient bulb may be replaced with a more efficient bulb which gives off the same amount of light while consuming less electricity. Also referred to as conservation measures.

Electricity – a form of energy which may be manufactured or generated from a variety of fuels, such as natural gas, oil, uranium or falling water. Electricity generated for delivery to utility customers is normally measured in two ways – power and energy.

Power is the capacity or potential to generate or consume electricity, and is measured in watts or multiples of watts (see "units of measure"). A 60-watt bulb consumes 60 watts of electricity, while a 600-megawatt generating station has the potential to deliver 600 megawatts (600 million watts) of electricity.

Energy is the amount of electricity actually delivered or consumed over a certain period of time. Electrical energy is measured in watt-hours and multiples thereof. If a 60-watt bulb burns for two hours, it consumes 120 watt-hours of energy. A typical household might consume 1,000 or 1,500 kilowatt-hours in a month. Residential electricity charges are based on the number of kilowatt-hours consumed in the billing period. If a 600-megawatt generating station runs at full capacity for just one hour, it delivers 600 megawatt-hours – that's 600,000 kilowatt-hours – of energy. The total energy supplied by Hydro's entire system is measured in terawatt- hours – billions of kilowatt-hours. See "units of measure".

Energy – see "electricity".

Firm purchase – a purchase of electricity by one utility from another under contract, arranged in advance of delivery and lasting a substantial length of time. Ontario Hydro has arranged for a firm purchase of 1,000 megawatts from Manitoba Hydro, starting in 1998.

Fuels – the primary energy sources used in the generation of electricity. The three major fuels used by Ontario Hydro are falling water (see "hydraulic"); uranium in nuclear reactors (see "CANDU"); and the fossil fuels, coal, oil and natural gas, which are the product of fossil remains buried in the ground.

Gigawatt(-hour) – see "units of measure".

Greenhouse gas emissions – gases like carbon dioxide (CO_2) and methane trap heat in the earth's atmosphere and are believed to contribute to global warming, the so-called "greenhouse effect". Fossil generating stations emit about 800 to 900 grams of CO_2 for every kilowatt-hour of generation.

Grid – Hydro's integrated, province-wide electricity delivery network (see "transmission").

Hydraulic – refers to the generation of electricity by means of falling water. Often used interchangeably with "hydro-electric", both terms deriving from the Greek word for "water". Hydraulic generating stations use the energy in falling water to spin turbines that produce electricity.

Interconnections – the points where Hydro's grid* interconnects with the grids of neighbouring utilities. They increase reliability* and allow these utilities to purchase electricity from each other when it is economic for both parties to do so.

Interruptible contract – an arrangement between Hydro and a customer stipulating that, in return for a reduced price, the customer will curtail use of some portion of their load at Hydro's request. The benefit to Hydro is that generating capacity requirements are reduced. Interruptions of service occur when the total customer demand on the Hydro system is about to exceed its capacity*. The total load that can be interrupted under these arrangements is known as "capacity interruptible load".

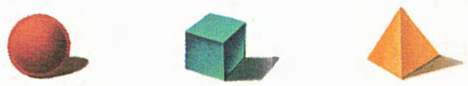
Kilowatt(-hour) – see "units of measure".

Load – the total amount of electrical power needed by customers at any given time.

Load forecasting – Hydro's prediction of the total load or demand customers will make on the electricity system (see also "bandwidth forecast").

Load-meeting capability – the customer demand that a station or system can meet reliably over time, taking into account a reserve for factors such as uncertainty in the load and shutdown of generators. For example, a generating station with a rated capacity of 600 megawatts has a load-meeting capability of about 485 megawatts. The difference between these two rating figures – 115 MW – represents Hydro's reserve margin*, calculated as 24% of the planning firm load* (24% of 485 MW = 115 MW).

Load shifting – a demand management technique which encourages customers to shift electrical load or consumption from peak to off-peak hours. Load shifting reduces the need for generating facilities and permits the use of lower cost fuels. Hydro defines daily off-peak hours as falling between 11:00 PM and 7:00 AM.



Load shape – a consistent pattern of rising or falling customer demand over a period of time. Load or demand has a typical daily, weekly and seasonal shape, determined by prevailing weather conditions and social patterns such as hours of sleeping, waking and working.

Megawatt(-hour) – see "units of measure".

Mothballing – the temporary closure of a generating station whose capacity is not needed, but which may be brought back into service in a reasonably short time.

Municipal utilities – along with Ontario Hydro, the members of the "Hydro family" that provides virtually all the electricity consumed in Ontario. While Hydro has a number of direct rural and industrial customers, most of its customer base is served at the retail level by one of over 300 municipal utilities.

Non-utility generation – electrical generation in Ontario owned and operated by producers other than Ontario Hydro. Usually divided into two types. "Load-displacement generation" is electricity produced for the producing customer's own needs. "Purchase generation" is electricity produced for sale to Hydro.

Ontario Energy Board (OEB) – an independent tribunal whose main function is to regulate natural gas utility operations, as well as to review the wholesale rates charged by Ontario Hydro. On the basis of public hearings held to discuss Hydro rates, the OEB makes recommendations to the Minister of Energy, while Hydro's Board of Directors makes final decisions on new rate levels.

Options – different means of supplying or reducing electricity demand, such as hydraulic* generation or demand management*. Fossil and nuclear generation options differ according to their size or capacity, environmental controls, number of units built per station and the process used to convert the primary energy source into electricity. See "fuels" and "CANDU".

Planning firm load – the total customer demand that Hydro must meet, excluding interruptible loads (see "interruptible contracts"). See "reserve margin".

Power – see "electricity".

Rehabilitation – major restoration or improvement of a generating unit's long-term performance, to maintain or extend service life, comply with environmental and safety regulations, or replace inefficient or obsolete equipment.

Reliability – To electricity customers, reliability is simply continuity of service. The reliability of a generating station is a measure of its performance, or how much of the time it is available to generate electricity.

Reserve margin – the generating capacity added to planning firm load* to maintain reliability* standards by allowing for factors such as uncertainty in load and outages for plant maintenance and breakdowns. Hydro's reserve margin is 24% of planning firm load. In other words, required system capacity is roughly equal to the planning firm load plus the necessary reserve margin.

Resources – in reference to electricity service, any technology, program or measure that helps meet customer demand for electricity. Resources drawn on by Ontario Hydro include rehabilitation* of existing plant, demand management*, non-utility generation*, hydraulic* generation, purchases from other utilities (see "firm purchases") and new major generating stations. Other resources with more specialized applications include the use of solar and wind power, and the burning of municipal waste.

Terawatt(-hour) – see "units of measure".

Transmission – Hydro's transmission system delivers electricity along high-voltage lines to local distribution networks, which then deliver the electricity to customers. Because of the great distances involved in moving electricity across Ontario, some delivery losses occur which must be accounted for in planning total customer needs.

Units of measure – In the context of electricity system planning, the amounts of electricity involved are very large, and it is therefore convenient to use multiples of the basic watt and watt-hour. For power, these are kilowatts, megawatts and gigawatts; for energy, kilowatt-hours, megawatt-hours, gigawatt-hours and terawatt-hours. The equivalences are as follows:

Power

- 1 kilowatt (kW) = 1,000 watts
- 1 megawatt (MW) = 1,000 kilowatts = 1 million watts
- 1 gigawatt (GW) = 1,000 megawatts = 1 billion watts

Energy

- 1 kilowatt-hour (kWh) = 1,000 watt-hours
- 1 megawatt-hour (MWh) = 1,000 kilowatt-hours = 1 million watt-hours
- 1 gigawatt-hour (GWh) = 1,000 megawatt-hours = 1 billion watt-hours
- 1 terawatt-hour (TWh) = 1,000 gigawatt-hours = 1 trillion watt-hours.

"The corporation cannot abandon its traditional goals of supplying reliable power at the best possible price. Certainly, reliability will be even more critical to businesses operating in the high-tech world of the late 20th Century. But in the continued delivery of those goals, the emphasis will have to move from cost to value, from systems to individuals, from telling to listening, in an effort to emphasize innovation while building on our traditional strengths."

R.C. Franklin

Chairman and President

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